DOCUMENT RESUME

ED 269 269 SE 046 588

AUTHOR Kouba, Vicky L.; Moser, James M.
TITLE Results from Fifth Individual Interview (January 1980), Coordinated Study No. 1. Working Paper No. 293.
INSTITUTION Wisconsin Univ., Madison. Research and Development Center for Individualized Schooling.
SPONS AGENCY National Inst. of Education (ED), Washington, DC.
PUB DATE Jul 80
GRANT OB-NIE-G-80-0117
NOTE 120p.; For related documents, see SE 046 583-590.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC05 Plus Postage.
DESCRIPTORS *Addition; Educational Research; *Elementary School Mathematics; Error Patterns; Grade 2; Interviews; Manipulative Materials; *Mathematics Instruction; Primary Education; *Problem Solving; *Subtraction
IDENTIFIERS *Mathematics Education Research

ABSTRACT

Data are reported from the fifth individual interview conducted in 1980 as part of a 3-year study on addition and subtraction using verbal problem solving. Ninety-six second-grade children in two schools in Wisconsin that used the Developing Mathematical Processes program were individually administerd six problem types (two solvable by addition and four solvable by subtraction) given under four conditions involving size of numbers and presence or absence of manipulative materials. Individual student profiles are discussed first, followed by a summary of pupil response data. Several important aspects of the summary data are isolated for contrast and comment. Finally, some secondary analyses of combined data are given. Appendices contain sample problem tasks and individual student profiles. (MNS)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

R. Rossmiller

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Working Paper 293

Results From Fifth Individual Interview (January, 1980), Coordinated Study #1

by

Vicky L. Kouba and James M. Moser

Report from the Project on

Studies in Mathematics

Thomas A. Romberg and Thomas P. Carpenter

Faculty Associates

James M. Moser

Senior Scientist

Wisconsin Research and Development Center
for Individualized Schooling
The University of Wisconsin
Madison, Wisconsin

July 1980

Published by the Wisconsin Research and Development Center for Individualized Schooling. The project presented or reported herein was performed pursuant to a grant from the National Institute of Education, Department of Health, Education, and Welfare. However, the opinions expressed herein do not necessarily reflect the position or policy of the National Institute of Education, and no official endorsement by the National Institute of Education should be inferred.

Center Grant No. OB-NIE-G-80-0117

BEST COPY AVAILABLE

MISSION STATEMENT

The mission of the Wisconsin Research and Development Center is to improve the quality of education by addressing the full range of issues and problems related to individualized schooling. Teaching, learning, and the problems of individualization are given concurrent attention in the Center's efforts to discover processes and develop strategies and materials for use in the schools. The Center pursues its mission by

- conducting and synthesizing research to clarify the processes of school-age children's learning and development
- conducting and synthesizing research to clarify effective approaches to teaching students basic skills and concepts
- developing and demonstrating improved instructional strategies, processes, and materials for students, teachers, and school administrators
- providing assistance to educators which helps transfer the outcomes of research and development to improved practice in local schools and teacher education institutions

The Wisconsin Research and Development Center is supported with funds from the National Institute of Education and the University of Wisconsin.

WISCONSIN RESEARCH AND DEVELOPMENT
CENTER FOR INDIVIDUALIZED SCHOOLING

Table of Contents

	Page
List of Tables	vii
List of Figures	ix
Introduction	1
Background Information	4
Population and Curriculum Materials	4
Interview Tasks	5
Interview Method	11
Coding Subject Responses	14
Presentation of Data	18
Individual Student Profiles	19
A Summary of Behaviors by Task and Level	21
Levels of Difficulty	30
Comparative Difficulty of Addition vs. Subtraction	30
Similarity of Response Patterns for the Two Addition Tasks	30
Subtraction Strategies and Problem Structure	32
The "Mental" Strategies	36
Less Frequently Occurring Strategies	36
Errors	36
Secondary Analyses of Data	37
Relationship of Strategy Employed to Correctness of Response	37
Relationship of Model Used to Correctness of Response	44
Consistency of Student Response	44
Conclusion	50
Reference Notes	53
References	54
Appendix A. Problem Tasks by Level	55
Appendix B. Individual Student Profiles	61
Appendix C. Number Set Assignment for Number Triples	87

List of Tables

Tables		Page
1.	Number and Age of Population by School	6
2.	Representative Problem Types	8
3.	Listing of Number Triples Used in Verbal Problems	10
4.	b+ and b- Number Triples	12
5.	c+ and c- Number Triples	12
6.	Interviewer School Assignment	13
7.	Task 1 (Addition-Joining) Number (%) of Children Coded for a Particular Behavior	24
8.	Task 2 (Subtraction-Separating) Number (%) of Children Coded for a Particular Behavior	25
9.	Task 3 (Subtraction-Part-Part-Whole, missing addend) Number (%) of Children Coded for a Particular Behavior	26
10.	Task 4 (Addition-Part-Part-Whole) Number (%) of Children Coded for a Particular Behavior	27
11.	Task 5 (Subtraction-Joining, missing addend) Number (%) of Children Coded for a Particular Behavior	28
12.	Task 6 (Subtraction-Joining, missing addend) Number (%) of Children Coded for a Particular Behavior	29
13.	Number of Correct Responses Per Task Across Levels	31
14.	Average Number of Correct Responses for Addition and Subtraction Problems by Level	31
15.	Number of Responses on Two Verbal Addition Problems	33
16.	Number of Responses for Different Subtraction Strategies by Problem and Level	34
17.	Frequency of Errors Across the Six Problem Tasks	38
18.	Level b+: Number of Children Employing a Strategy	39
19.	Level b-: Number of Children Employing a Strategy	40
20.	Level c+: Number of Children Employing a Strategy	41
21.	Level c-: Number of Children Employing a Strategy	42

List of Tables

Tables	Page
22. Level b+: Number of Children Employing a Model	45
23. Level b-: Number of Children Employing a Model	46
24. Level c+: Number of Children Employing a Model	47
25. Level c-: Number of Children Employing a Model	48
26. Number of Children Who Gave Response Maximum Number of Times Across Tasks by Level	51
27. Number of Children Who Gave Response Maximum Number of Times Across Levels by Task	52

List of Figures

Figures		Page
1.	Factors influencing pupil performance	2
2.	Conditions for nonsymbolic problem types	9
3.	Electronically scored interviewer coding sheet	15
4.	Sample student profile	20

A major aim of mathematical instruction is to enable students to acquire concepts and skills requisite for solving problems of many types. A principle goal of mathematical education research is to understand how children acquire those concepts and skills and to understand how selected pedagogical and psychological factors are related to their acquisition. The Mathematics Work Group of the Wisconsin Research and Development Center for Individualized Schooling is presently conducting a program of research focused on a small set of those concepts and skills. Our interest lies in arithmetical learning, and in particular, in the acquisition of concepts and skills related to addition and subtraction of whole numbers.

The research program is attempting to relate pupil performance on selected arithmetic skills to pupil cognitive processes, instructional materials, and teachers' classroom behaviors. The interrelationship of these variables is depicted in Figure 1. Using this framework, we are proceeding to:

1. identify important addition and subtraction skills;
2. review past empirical data or collect new data on these skills;
3. re-examine these mathematical skills and hypothesize how they are related to underlying cognitive skills;
4. examine the instructional materials designed to teach these skills; and
5. conduct a series of empirical studies on the appropriateness of particular teacher classroom behaviors, the appropriateness of instructional materials, and the relationship of specific cognitive skills to

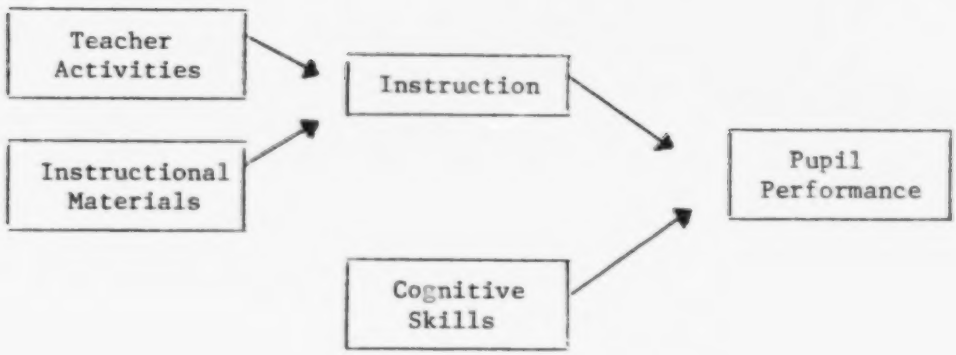

Figure 1. Factors influencing pupil performance.

mathematical skills.

The work of the Mathematics Work Group is built around the conceptual framework exemplified in Figure 1. The empirical and theoretical investigations generally involve two or more of the factors depicted, and have been organized into four major categories. These are a conceptual paper series, a set of short empirical studies, a major longitudinal study, and an invitational conference of scholars.

This paper relates to the longitudinal study. Approximately 150 students in three separate schools were identified as subjects for the study. One school with about 50 students chose not to continue into the second year of the study. Thus, about 100 children are being followed for three school years. Pupil performance is measured in several ways:

1. Individual interviews. At several times during each school year, individual children are administered a set of problem tasks dealing with addition and subtraction. The interviewer attempts to ascertain the children's solution strategy, correctness of answer, type of errors made, and modeling procedures.

2. Group administered paper-and-pencil tests. There are two separate categories of tests:

    a. Achievement monitoring. These tests measure pupil progress toward a set of performance objectives that are contained in the instructional materials. By means of matrix sampling procedures, estimates are made of group performance. Achievement monitoring tests are given shortly after the completion of the instructional units related to arithmetic objectives.

b. Topic inventories. These are very short tests that measure pupil progress toward mastery of the objectives of a specific instructional unit, or topic. Every subject takes the same test, resulting in a measure of individual performance.

Instruction and classroom environment are assessed by direct classroom observation of teacher actions, pupil behaviors, and instructional materials. A trained observer is present each day the instructional units, or topics, dealing with arithmetic objectives are being used. Organizational and grouping measures are noted, along with indications of interactions between teacher and pupils, and among pupils. Measures of pupil engaged time are estimated by observing six target students.

The purpose of this paper is to report on the data from the fifth round of individual interviews for the longitudinal study, which were carried out during January 1980. In the first major section we present all the background information on subjects and the manner of data collection. In the following two major sections, summaries and interpretations of the data are given. Some of the actual data collected in the interviews appears in the Appendices.

Background Information

This section contains background information needed to understand the data summaries given in the next section. As indicated in the various subsections, greater detail may be obtained by referring to other reports from the Mathematics Work Group.

Population and Curriculum Materials

The fifth interview of individual children was carried out during the

period January 28-30, 1980, at the two participating schools:

School 1: a public school in Monona, Wisconsin.

School 3: a parochial school in Madison, Wisconsin.

The subjects for the study consisted of about 100 second grade students, all from predominantly middle class areas, who had parental permission to participate in the interviews. Table 1 presents the number of children who participated in the study in each school and information about their age when the interview was given.

Each of the schools used as their mathematics curriculum the Developing Mathematical Processes (DMP) program (Romberg, Harvey, Moser, and Montgomery, 1974). The following sequence of topics was suggested to the six teachers involved in the second year of the study: S-4, 30, S-5, 31, S-6, 33, A-1, 36, A-2, 39, A-3, 37 or 41, A-4. The S-series and A-series topics were specially prepared for the Longitudinal Study (see Kouba & Moser, Note 1 and Note 2).

The fifth interview was given after the instruction of Topic S-6. By this time in their mathematics instruction the children had been introduced to solving problem situations involving the numbers 0-20 and should have made substantial progress towards mastery of basic addition and subtraction facts.

Interview Tasks

The interview consisted of six problem types (tasks) given under four conditions. The four conditions are described later. The six types included two problems solvable by addition of the two given numbers and four problems solvable by subtraction of the two given numbers. The characterization for these six problem types is detailed in Moser (Note 3) and in Carpenter and

Table 1

Number and Age of Population by School

	School 1	School 3	Total
Number of children	63	33	96
Mean age	7 yr. 8 mo.	7 yr. 10 mo.	7 yr. 9 mo.
Maximum age	8 yr. 6 mo.	8 yr. 5 mo.	8 yr. 6 mo.
Minimum age	7 yr. 1 mo.	7 yr. 0 mo.	7 yr. 1 mo.
Male	34	21	55
Female	29	12	41

Moser (Note 4).

Table 2 presents representative problems and the order in which the problems were administered to the children. The actual wording for each problem type differed in the four conditions, but the semantic structure remained constant. The actual problems administered are given in Appendix A.

Within each problem, two of three numbers from a number triple (x, y, z) defined by $x + y = z$, $x < y < z$, were given. In the two addition problems x, y were presented, with the smaller number x always given first. In the four subtraction problems, z and the larger addend y were presented. The order of presentation of y and z varied among problem types.

The six problem types were presented under four conditions that result from crossing smaller numbers vs. larger numbers with presence vs. absence of manipulative materials. Figure 2 shows these four conditions with the labels assigned to them. In the b+ and c+ conditions approximately 30 small plastic cubes about equally divided between blue cubes and orange cubes were available to the child to use as manipulatives if desired.

The actual number triples used in the problems are listed in Table 3. We hypothesized before the interviews began that the four conditions would constitute different levels of difficulty with the b+ condition proving the easiest and the c- the most difficult. The ordering of difficulty of b- and c+ was left to the empirical results. The four conditions became known as the four levels, and that terminology will be used in the remainder of this paper.

The assignment of the number triples (small and large domains) to problem types involved a six-by-six Latin square design resulting in six sets of the

Table 2

Representative Problem Types

Task 1. Joining (Addition)	Wally had 3 pennies. His father gave him 5 more pennies. How many pennies did Wally have altogether?
Task 2. Separating (Subtraction)	Tim had 11 candies. He gave 7 candies to Martha. How many candies did Tim have left?
Task 3. Part-Part-Whole Missing Addend (Subtraction)	There are 6 children on the playground. 4 are boys and the rest are girls. How many girls are on the playground?
Task 4. Part-Part-Whole (Addition)	Sara has 6 sugar donuts. She also has 9 plain donuts. How many donuts does Sara have altogether?
Task 5. Comparison (Subtraction)	Joe has 3 balloons. His sister Connie has 5 balloons. How many more balloons does Connie have than Joe?
Task 6. Joining Missing Addend (Subtraction)	Kathy has 5 pencils. How many more pencils does she have to put with them so she has 7 pencils altogether?

		Number Size: smaller	Number Size: larger
Presence of manipulatives	with	b+	c+
	without	b-	c-

Figure 2. Conditions for nonsymbolic problem types.

Table 3

Listing of Number Triples Used in Verbal Problems

Smaller numbers	Larger numbers
2-3-5	3-8-11
2-4-6	4-7-11
2-5-7	5-7-12
3-4-7	4-9-13
2-6-8	6-8-14
3-6-9	6-9-15

six problem types. These sets were uniformly and randomly distributed across subjects. The Latin squares for the small number domain (b) and the large number domain (c) are presented in Tables 4 and 5 respectively. The number in the box (□) in each entry represents the solution the children were to find. The order of the other two given numbers in the tables corresponds to the order in which those numbers appeared in the problem (cf. Table 2). The assignment of problem sets to subjects is listed in Appendix C.

Task sets for a particular level were assigned to children so that the same number triple did not occur in the same problem type (task) in any subsequent interview.

Interview Method

Trained interviewers (see Martin & Moser, Note 5, for details of interviewer training and reliability) administered the interviews. The interview process for the two schools took three days, the 28th to 30th of January, 1980. Two or three interviewers worked at a given school on each day. Interviews began soon after school started and continued through the day, with the usual breaks at lunch and recess. Table 6 details the assignment of interviewers to schools.

Each interviewer was able to conduct 8 to 18 interviews in a day, depending on the schools' schedules and on the task level. (Level c tasks took longer than level b tasks.) At the schools the interviewers were assigned interview areas, which, for the most part, were quiet rooms separate from distracting activities.

The interviewers went to the classroom to get a child, and they visited together on the way to the interview area. The verbal tasks were reread to the child as often as necessary so that remembering the given numbers or

Table 4

b+ and b- Number Triples

Set number	Task 1	2	3	4	5	6
1	3,6,[9]	7,5,[2]	5,3,[2]	2,4,[6]	4,7,[3]	6,8,[2]
2	2,6,[8]	7,4,[3]	6,4,[2]	3,6,[9]	3,5,[2]	5,7,[2]
3	2,5,[7]	8,6,[2]	9,6,[3]	3,4,[7]	4,6,[2]	3,5,[2]
4	3,4,[7]	6,4,[2]	8,6,[2]	2,3,[5]	5,7,[2]	6,9,[3]
5	2,4,[6]	5,3,[2]	7,5,[2]	2,6,[8]	6,9,[3]	4,7,[3]
6	2,3,[5]	9,6,[3]	7,4,[3]	2,5,[7]	6,8,[2]	4,6,[2]

Table 5

c+ and c- Number Triples

Set number	Task 1	2	3	4	5	6
1	6,9,[15]	13,9,[4]	11,8,[3]	4,7,[11]	7,12,[5]	8,14,[6]
2	6,8,[14]	12,7,[5]	11,7,[4]	6,9,[15]	8,11,[3]	9,13,[4]
3	4,9,[13]	14,8,[6]	15,9,[6]	5,7,[12]	7,11,[4]	8,11,[3]
4	5,7,[12]	11,7,[4]	14,8,[6]	3,8,[11]	9,13,[4]	9,15,[6]
5	4,7,[11]	11,8,[3]	13,9,[4]	6,8,[14]	9,15,[6]	7,12,[5]
6	3,8,[11]	15,9,[6]	12,7,[5]	4,9,[13]	8,14,[6]	7,11,[4]

Table 6

Interviewer School Assignment

Interviewer code #	Date		
	1/28	1/29	1/30
12			School 1
30	School 1	School 1	School 1
34	School 1	School 1	School 1
41		School 1	
45	School 3	School 3	
72	School 3	School 3	School 3

relationships caused no difficulty.

An individual interview required two sessions, one for b+ and b-, and the other for c+ and c- tasks. The sessions lasted 10-20 minutes each, with each child receiving the same sequence of problems. No child was interviewed twice in one day.

If a child had extreme difficulty in responding to b+ tasks, the interview was broken off at that level. After each level, the interviewer decided whether the child should proceed to the next level in the sequence b+, b-, c+, c-.

Coding Subject Responses

All of the possible student responses are presented in detail in Cookson and Moser (Note 6). Only a brief description is presented here. The coding sheet upon which responses were recorded is shown in Figure 3.

Model

C The child used cubes to model (all or part of) the problem.

F The child used fingers to model.

N The child used no physical model.

O The child used some other physical mode, such as chairs, numerals on a clock face.

Correctness

Y The answer was correct.

N The answer was not correct.

UN Uncodable: The child gave an answer, but the interviewer was unable to identify the strategy used.

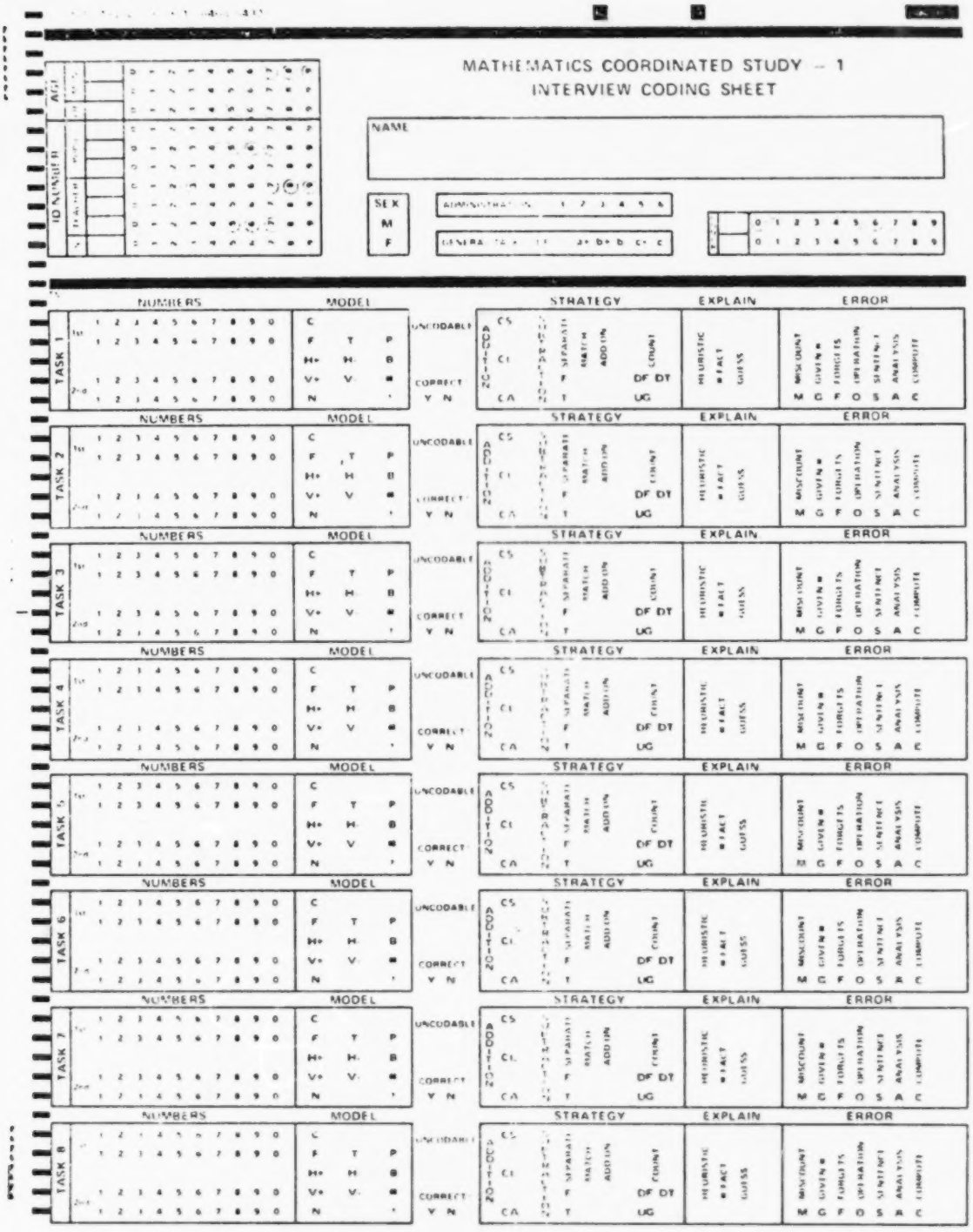

Figure 3. Electronically scored interviewer coding sheet.

BEST COPY AVAILABLE

Strategy

Addition:

CS Counting On from Smaller or Counting On from First Number: When counting cubes, fingers, or mentally, the counting sequence began either with the smaller number (first number given in the story) or the successor of that number.

CL Counting On from Larger: The counting sequence began with the larger (second) given number or with the successor of that number.

CA Counting All: The child counted the complete union of the sets represented in the problem, with counting sequence started at "one, two, ..."

S Subitizing: The child models the two addends and "recognizes" the sum without counting.

Subtraction:

F Separate From: The child models the larger given set and then takes away or separates, one at a time, a number of cubes or objects equal to the smaller given number in the problem. Counting the remainder set gives the answer.

T Separate To: After the larger set is modeled, the child removes cubes or objects one at a time until the remainder is equal to the second given number in the problem. Counting the number of objects removed gives the answer.

MA Match: The child puts out two sets of cubes or objects, each set standing for one of the given numbers. The sets are then matched one-to-one. Counting the excess of the larger set over the smaller

set gives the answer.

AO Add On: The child sets out a number of cubes or objects equal to the smaller given number (an addend). The child then adds cubes to that set one at a time until the new collection is equal to the larger given number. Counting the number of cubes added on gives the answer.

DF Count Down From: A child initiates a backwards counting sequence beginning with the larger given number. The backwards counting sequence contains as many counting number words as the smaller given number. The last number uttered in the counting sequence is the answer.

DT Count Down To: A child initiates a backwards counting sequence beginning with the larger given number. The sequence ends with the given smaller number. By keeping track of the number of counting words uttered in this sequence, the child determines the answer to be the number of counting words used in the sequence.

UG Count Up from Given: A child initiates a forward counting sequence beginning with the smaller given number. The sequence ends with the larger given number. Again, by keeping track of the number of counting words uttered in sequence, the child determines the answer.

Addition and Subtraction (Explain or Mental Processes):

HU Heuristic: Heuristic strategies were employed to generate solutions from a small set of known basic facts. These strategies usually were based on doubles or numbers whose sum was 10.

#F Number Fact: The child gave a correct answer with the justification

that it was the result of knowing some basic addition/subtraction fact.

GU Guess: The child gave an answer with the justification that it was the result of guessing.

Error:

M Miscount: The child miscounted in some way.

G (GI) Given Number: The child responded that the answer was one of the two numbers given in the problem.

F Forgets: The child forgot one of the given numbers and thereby found an incorrect answer.

O (OP) Operation: The child used an addition strategy in a problem that must be solved through subtraction, or a subtraction strategy was employed in an addition problem.

None of the other items under model, strategy, and error on the coding sheets was used for this interview.

Presentation of the Data

Data were collected on children's behavior following presentation of a specific verbal problem. The six different verbal problem types were presented at four different levels, resulting in a maximum of 24 tasks for an individual child. For reasons to be explained later, not all children received all tasks. Of the 96 children who began the interviews all but 2 were administered the complete set of 24 tasks.

This section begins with a discussion of individual student profiles, which comprise the basic raw data, followed by a summary of pupil response data. Several important aspects of the summary data are isolated for contrast and comment. The following major section will present some secondary analyses

of combined data.

Individual Student Profiles

A record of each subject's response to the 24 tasks was compiled from the coding sheets. These profiles are the basis for all other statistical information appearing in this paper. The profiles for all subjects are contained in Appendix B. Figure 4 provides an example of a student profile.

For each task at each level, the four coded entries in order from left to right are model, correctness, strategy, and error. The abbreviations used are explained in the previous section. In the strategy column (as in much of the data analysis for this study) Uncodable (UN), Given Number (GI), and Operation (OP) were treated as strategies.

The hundreds digit of the student ID number identified which school the student attended: 1 or 3 (see Table 1).

The actual problem and numbers used in the problem for a given level and task can be obtained by using the following procedure. For example, what was the actual problem read to Student 133 for Task 2 at the b- level?

1. Use Appendix A, Problem Tasks by Level, to find the exact wording for Task 2 at the b- level:

> Joan had ____ apples.
> She gave ____ apples to Louise.
> How many apples did Joan have left?

2. Use Appendix C, Number Set Assignment, to find what set was assigned to Student 133 at the b- level. The entry in the b- column for ID #133 is 4.

3. Use Table 4, b+ and b- Number Triples, to find what number triple was assigned to set 4, Task 2. The entry in this table is 6, 4, [2] , where [2] indicates that 2 is the correct solution. Therefore, Student #133 was given the following problem for Task 2, level b-:

Student ID Number

133	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CA -	C Y F -	C N UN -	C Y CA -	C N GI GI	C Y AO -
b-	F Y CA -	F Y F -	- ? ? -	F Y CA -	F N GI GI	F Y AO -
c+	C Y CA -	C Y F -	N N OP O	F Y CA -	N N GI GI	C Y AO -
c-	F ? ? -	O N F -	F N OP O	F N UN -	N N GI GI	F N AO M

Level

model
correct
strategy
error

Figure 4. Sample student profile.

Joan had 6 apples.
She gave 4 apples to Louise.
How many apples did Joan have left?

Looking at Figure 4, we can reconstruct this child's behavior. The first F indicates the child used fingers to model. The next entry, Y, indicates the problem was solved correctly. This accounts for the hyphen in the fourth column, indicating no error. The F in the third column indicates the child used a Separate From strategy. This means the child counted out a set of 6 fingers, then took four away to get two remaining fingers. The child reported "two" as the answer.

Some general understanding of individual students can be achieved by looking at a profile. For example, when considering Figure 4 for Student 133, one might conclude:

1. The student did not do well on any problems when no cubes were available to model the problem and when the numbers were greater than 10. (c-)

2. Task 3 was never interpreted correctly or consistently.

3. The student uses a Counts all strategy when adding and Separate From or Add On strategy when subtracting, indicating that his/her level of response is still dependent upon modeling all the numbers.

4. The student consistently misinterpreted Task 5.

A Summary of Behaviors by Task and Level

Each of the four major categories of responses - modeling, correctness, strategy, and error - have been summarized for each of the 24 tasks presented. As indicated in the first major section of this paper, a six-by-six Latin square design was used to distribute the number triples across tasks and across subjects. An initial, informal statistical analysis of the number

triples as a variable affecting subject responses showed that the triples have little effect.

Three population subsets. The general goal for the interviews was to present each child with the b+ and b- problems during the first interview session and with the c+ and c- problems during the second session a day or two later. However, if a child was incapable of solving all problems, the interviewer had the responsibility to determine at what point a particular level was inappropriate for that child. These guidelines were initially established at the beginning of the longitudinal study:

1. If during the b+ portion of the interview the child fails to use any coherent or identifiable strategies while trying to solve three of the first four problems, terminate the b portion.

2. If the child solves two of the first four b+ problems, but is baffled by the last two problems, i.e., solves two of the six problems, terminate the b portion of the interview.

The interview was terminated, not because three of the four problems were incorrect, but because the child was perplexed by the problem and employed highly inappropriate strategies or because the interviewer was unable to determine what strategies were being employed.

3. If the child solved at least two of the first four and at least one of the last two of the b+ problems, present the b- problems. The b- portion should be completed unless the child cannot solve three of the first four problems.

4. The decision whether the child should go on to the c portion was made at the end of the b interview.

The procedure for determining whether to terminate the c+ or c- level interview followed the same guidelines as those given above. For this interview, all children completed the b+, b-, and c+ portions, and only two children did not complete the c- portion.

As a result of the policy of terminating the interview before completion, three sets of subjects were identified.

Total population N=96. This is the total interview population and consists of all children who were interviewed, no matter when the interview terminated.

Real population $94 \leq N \leq 96$. This is the number of subjects who actually were administered each task. This number can change for each task or level.

Successful population N=94. This is the number of subjects who were administered all 24 tasks.

The results describe only the Total population, for that is the most representative of the childrens' responses. Although the decisions to terminate interviews resulted in incomplete data for two students, the decision rules were designed so that it is valid to assume that these children would have given incorrect answers or used uncodable strategies on the questions that were presented. That is, the children consistently had been giving uncodable incorrect answers or were simply confused on all previous problems. Thus, it was a reasonable assumption that subsequent responses would follow the same pattern.

A table for each of the six tasks is presented (Tables 7-12). All four levels for each task are contained in the same table. The uncodable (UN) and confused (?) responses are included in the strategy category. All data are based on the total of 96 subjects.

Table 7

Task 1 (Addition-Joining)

Number (%) of Children Coded for a Particular Behavior

		Level			
		b+	b-	c+	c-
C	Cubes	18(19%)	0(0%)	26(27%)	0(0%)
F	Fingers	3(3%)	17(18%)	13(14%)	24(25%)
N	No Action	75(78%)	79(82%)	57(59%)	70(73%)
O	Other	0(0%)	0(0%)	0(0%)	0(0%)
Y	Correct	91(95%)	93(97%)	84(88%)	79(82%)
UN	Uncodable	2(2%)	3(3%)	1(1%)	6(6%)
?	Confusion	0(0%)	0(0%)	0(0%)	1(1%)
CS	Counts On from Smaller	4(4%)	9(9%)	13(14%)	9(9%)
CL	Counts On from Larger	21(22%)	15(16%)	30(31%)	30(31%)
S	Subitizing	2(2%)	4(4%)	0(0%)	0(0%)
CA	Counts All	9(9%)	5(5%)	18(19%)	2(2%)
HU	Heuristic	1(1%)	4(4%)	11(11%)	16(17%)
#F	Number Fact	55(57%)	55(57%)	21(22%)	27(28%)
GU	Guess	2(2%)	0(0%)	2(2%)	3(3%)
GI	Given Number	0(0%)	1(1%)	0(0%)	0(0%)
OP	Wrong Operation	0(0%)	0(0%)	0(0%)	0(0%)
M	Miscount	1(1%)	0(0%)	7(7%)	3(3%)
F	Forgets Data	1(1%)	0(0%)	0(0%)	1(1%)
	Not administered	0(0%)	0(0%)	0(0%)	2(2%)

Table 8

Task 2 (Subtraction-Separate)

Number (%) of Children Coded for a Particular Behavior

		Level			
		b+	b-	c+	c-
C	Cubes	29(30%)	0(0%)	35(36%)	0(0%)
F	Fingers	7(7%)	19(20%)	7(7%)	26(27%)
N	No Action	60(63%)	77(80%)	55(57%)	65(67%)
O	Other	0(0%)	0(0%)	0(0%)	1(1%)
Y	Correct	85(89%)	86(90%)	79(83%)	69(72%)
UN	Uncodable	4(4%)	3(3%)	2(2%)	6(6%)
?	Confusion	0(0%)	0(0%)	0(0%)	3(3%)
F	Separate from	35(36%)	19(20%)	33(34%)	14(15%)
T	Separate to	0(0%)	0(0%)	0(0%)	0(0%)
MA	Match	0(0%)	0(0%)	0(0%)	0(0%)
AO	Add On	0(0%)	0(0%)	1(1%)	1(1%)
DF	Count Down from	5(5%)	5(5%)	8(8%)	11(11%)
UG	Count Up from Given	6(6%)	7(7%)	10(10%)	12(13%)
DT	Count Down to	0(0%)	0(0%)	3(3%)	2(2%)
HU	Heuristic	3(3%)	5(5%)	9(9%)	9(9%)
#F	Number Fact	37(39%)	52(54%)	20(21%)	30(31%)
GU	Guess	4(4%)	4(4%)	10(10%)	4(4%)
GI	Given Number	0(0%)	1(1%)	0(0%)	2(2%)
OP	Wrong Operation	2(2%)	0(0%)	0(0%)	0(0%)
M	Miscount	4(4%)	1(1%)	5(5%)	7(7%)
F	Forgets Data	0(0%)	2(2%)	0(0%)	1(1%)
	Not administered	0(0%)	0(0%)	0(0%)	2(2%)

Table 9

Task 3 (Subtraction-Part-Part-Whole, missing addend)

Number (%) of Children Coded for a Particular Behavior

		Level			
		b+	b-	c+	c-
C	Cubes	26(27%)	0(0%)	33(34%)	0(0%)
F	Fingers	9(9%)	22(23%)	10(10%)	31(32%)
N	No Action	61(64%)	71(74%)	55(57%)	63(66%)
O	Other	0(0%)	1(1%)	0(0%)	0(0%)
Y	Correct	75(78%)	77(80%)	75(78%)	63(66%)
UN	Uncodable	4(4%)	5(5%)	3(3%)	3(3%)
?	Confusion	0(0%)	2(2%)	0(0%)	0(0%)
F	Separate from	27(28%)	19(20%)	35(36%)	16(17%)
T	Separate to	0(0%)	0(0%)	0(0%)	0(0%)
MA	Match	0(0%)	0(0%)	0(0%)	0(0%)
AO	Add On	0(0%)	1(1%)	0(0%)	1(1%)
DF	Count Down from	6(6%)	4(4%)	5(5%)	10(10%)
UG	Count Up from Given	6(6%)	6(6%)	11(11%)	14(15%)
DT	Count Down to	0(0%)	0(0%)	1(1%)	2(2%)
HU	Heuristic	4(4%)	1(1%)	13(14%)	12(13%)
#F	Number Fact	35(36%)	47(49%)	19(20%)	21(22%)
GU	Guess	3(3%)	3(3%)	5(5%)	11(11%)
GI	Given Number	6(6%)	4(4%)	3(3%)	2(2%)
OP	Wrong Operation	5(5%)	4(4%)	1(1%)	2(2%)
M	Miscount	3(3%)	0(0%)	10(10%)	11(11%)
F	Forgets Data	0(0%)	1(1%)	0(0%)	1(1%)
	Not administered	0(0%)	0(0%)	0(0%)	2(2%)

Table 10

Task 4 (Addition-Part-Part-Whole)

Number (%) of Children Coded for a Particular Behavior

		Level			
		b+	b-	c+	c-
C	Cubes	20(21%)	0(0%)	17(18%)	0(0%)
F	Fingers	8(8%)	20(21%)	15(16%)	25(26%)
N	No Action	68(71%)	76(79%)	64(67%)	68(71%)
O	Other	0(0%)	0(0%)	0(0%)	0(0%)
Y	Correct	94(98%)	91(95%)	84(88%)	80(83%)
UN	Uncodable	2(2%)	2(2%)	4(4%)	6(6%)
?	Confusion	0(0%)	0(0%)	0(0%)	1(1%)
CS	Counts On from Smaller	7(7%)	7(7%)	8(8%)	13(14%)
CL	Counts On from Larger	25(26%)	18(19%)	32(33%)	28(29%)
S	Subitizing	4(4%)	7(7%)	0(0%)	0(0%)
CA	Counts All	7(7%)	2(2%)	10(10%)	2(2%)
HU	Heuristic	2(2%)	2(2%)	11(11%)	9(9%)
#F	Number Fact	48(50%)	56(58%)	25(26%)	32(33%)
GU	Guess	1(1%)	2(2%)	6(6%)	3(3%)
GI	Given Number	0(0%)	0(0%)	0(0%)	0(0%)
OP	Wrong Operation	0(0%)	0(0%)	0(0%)	0(0%)
M	Miscount	0(0%)	1(1%)	2(2%)	3(3%)
F	Forgets Data	1(1%)	2(2%)	1(1%)	1(1%)
	Not administered	0(0%)	0(0%)	0(0%)	2(2%)

Table 11

Task 5 (Subtraction-Comparison)

Number (%) of Children Coded for a Particular Behavior

		Level			
		b+	b-	c+	c-
C	Cubes	27(28%)	0(0%)	28(29%)	0(0%)
F	Fingers	6(6%)	20(21%)	13(14%)	24(25%)
N	No Action	62(65%)	76(79%)	57(59%)	69(72%)
O	Other	0(0%)	0(0%)	0(0%)	0(0%)
Y	Correct	75(78%)	75(78%)	67(70%)	62(65%)
UN	Uncodable	3(3%)	6(6%)	7(7%)	6(6%)
?	Confusion	1(1%)	0(0%)	0(0%)	2(2%)
F	Separate from	15(16%)	7(7%)	11(11%)	4(4%)
T	Separate to	0(0%)	0(0%)	0(0%)	0(0%)
MA	Match	9(9%)	2(2%)	13(14%)	0(0%)
AO	Add On	1(1%)	1(1%)	2(2%)	1(1%)
DF	Count Down from	1(1%)	2(2%)	6(6%)	8(8%)
UG	Count Up from Given	14(15%)	19(20%)	16(17%)	25(26%)
DT	Count Down to	0(0%)	0(0%)	0(0%)	0(0%)
HU	Heuristic	0(0%)	1(1%)	7(7%)	7(7%)
#F	Number Fact	41(43%)	42(44%)	18(19%)	23(24%)
GU	Guess	0(0%)	4(4%)	5(5%)	10(10%)
GI	Given Number	5(5%)	7(7%)	4(4%)	4(4%)
OP	Wrong Operation	6(6%)	5(5%)	7(7%)	4(4%)
M	Miscount	6(6%)	1(1%)	5(5%)	5(5%)
F	Forgets Data	3(3%)	1(1%)	1(1%)	1(1%)
	Not administered	0(0%)	0(0%)	0(0%)	2(2%)

Table 12

Task 6 (Addition-Joining, missing addend)

Number (%) of Children Coded for a Particular Behavior

		Level			
		b+	b-	c+	c-
C	Cubes	17(18%)	0(0%)	23(24%)	0(0%)
F	Fingers	3(3%)	16(17%)	12(13%)	34(35%)
N	No Action	76(79%)	80(83%)	62(65%)	59(61%)
O	Other	0(0%)	0(0%)	1(1%)	1(1%)
Y	Correct	93(97%)	91(95%)	89(93%)	83(86%)
UN	Uncodable	0(0%)	2(2%)	5(5%)	4(4%)
?	Confusion	0(0%)	0(0%)	0(0%)	0(0%)
F	Separate from	0(0%)	0(0%)	1(1%)	0(0%)
T	Separate to	0(0%)	0(0%)	0(0%)	1(1%)
MA	Match	0(0%)	0(0%)	0(0%)	0(0%)
AO	Add On	13(14%)	8(8%)	17(18%)	5(5%)
DF	Count Down from	0(0%)	0(0%)	2(2%)	0(0%)
UG	Count Up from Given	20(21%)	25(26%)	30(31%)	48(50%)
DT	Count Down to	0(0%)	0(0%)	0(0%)	0(0%)
HU	Heuristic	3(3%)	2(2%)	15(16%)	5(5%)
#F	Number Fact	59(62%)	57(59%)	24(25%)	29(30%)
GU	Guess	1(1%)	2(2%)	2(2%)	2(2%)
GI	Given Number	0(0%)	0(0%)	0(0%)	0(0%)
OP	Wrong Operation	0(0%)	0(0%)	0(0%)	0(0%)
M	Miscount	1(1%)	2(2%)	3(3%)	3(3%)
F	Forgets Data	1(1%)	0(0%)	0(0%)	1(1%)
	Not administered	0(0%)	0(0%)	0(0%)	2(2%)

Levels of Difficulty

Prior to the commencement of the longitudinal study, it was hypothesized that the four interview conditions, b+, b-, c+, c-, would represent sequential levels of difficulty. The number of students responding correctly to each task is presented in Table 13. By the time of this fifth interview, the difference in difficulty for the task levels is not readily apparent except to note that the c- tasks are still the most difficult. However, there is no difference at all between b+ and b-. While the c+ tasks appear to be more difficult than the b+ and b- tasks, the difference is very small, varying from one task to another.

Comparative Difficulty of Addition vs. Subtraction

Results from the earlier interviews were consistent with those of other research in that addition tended to be easier than subtraction. The average number of correct responses per level for the two addition problems was compared to the average number of correct responses for all four subtraction problems. For this interview the differences in favor of addition can be attributed to two problems, Task 3: Part-Part-Whole, missing addend and Task 5: Comparison. When an analysis is made with the addition problems and the two other subtraction problems, it can be seen that there is virtually no difference in difficulty level. (See Table 14).

Similarity of Response Patterns for the Two Addition Tasks

An earlier pilot study (Carpenter, Hiebert and Moser, Note 7) used the same two addition tasks and found almost no difference in the responses given by children to those tasks. The results from the fifth interview reflect this same consistency of response. It would appear that children of the age represented by this sample do not differentiate between an action-oriented Joining

Table 13

Number of Correct Responses Per Task Across Levels

	Level			
Task	b+	b-	c+	c-
1	91	93	84	79
2	85	86	79	69
3	75	77	75	63
4	94	91	84	80
5	75	75	67	62
6	93	91	89	83

Table 14

Average Number of Correct Responses for Addition and Subtraction Problems by Level

	Level			
Type	b+	b-	c+	c-
Tasks 1, 4 (Addition)	93	92	84	80
Tasks 2, 3, 5, 6 (Subtraction)	82	82	78	69
Tasks 2, 6 (Easier Subtraction)	89	89	84	76

addition problem and a static Part-Part-Whole addition problem. Table 15 presents the contrasts between the two problems on a level-by-level basis. Similar results were noted in previous interviews.

Subtraction Strategies and Problem Structure

Unlike the monolithic characterization of addition in the previous section, subtraction is not amenable to a single simple interpretation. A number of writers (e.g., Gibb, 1956) have suggested three interpretations, or structures, underlying subtraction. They are the subtractive, the additive, and the comparative. The four problem tasks were chosen with this categorization in mind. Task 2, Separating, reflects the subtractive notion in that its semantic structure strongly suggests the use of the separating or take-away strategy. Task 6, Joining, missing addend, reflects the additive notion in that its semantic structure suggests the additive strategy of adding-on or making a smaller set larger. Task 5, Comparison, reflects the static notion of comparison by suggesting neither adding on nor taking away, but rather a matching or contrasting of two sets. Task 3, Part-Part-Whole, missing addend, is the least suggestive of the four subtraction tasks since its semantic structure does not clearly indicate what strategy is most appropriate.

For purposes of discussion, the Separating From (F), Separating To (T), Counting Down From (DF) and Counting Down to (DT) strategies will be aggregated into a single subtractive category. Similarly, the Adding On (AO) and Counting Up from Given (UG) strategies will be aggregated into a single additive strategy. And finally, Matching (MA) is essentially the comparative strategy. Table 16 presents the frequency of these combined

Table 15

Number of Responses on Two Verbal Addition Problems

	Model		Correct		Strategy				
	C	F	N	Y	CA	CS	CL	#F	HU
b+ Joining	18	3	75	91	9	4	21	55	1
Part-Part-Whole	20	8	68	94	7	7	25	48	2
b- Joining	0	17	79	93	5	9	15	55	4
Part-Part-Whole	0	20	76	91	2	7	18	56	2
c+ Joining	26	13	57	84	18	13	30	21	11
Part-Part-Whole	17	15	64	84	10	8	32	25	11
c- Joining	0	24	70	79	2	9	30	27	16
Part-Part-Whole	0	25	68	80	2	13	28	32	9

Table 16

Number of Responses for Different Subtraction Strategies by Problem and Level

Level	problem type	Strategies			
		Subtractive	Additive	Comparative	Mental
b+	Separating	40	6	0	40
	Joining, missing addend	0	33	0	62
	Comparison	16	15	9	41
	Part-Part-Whole, missing addend	33	6	0	39
b-	Separating	24	7	0	57
	Joining, missing addend	0	33	0	59
	Comparison	9	20	2	43
	Part-Part-Whole, missing addend	23	7	0	48
c+	Separating	44	11	0	29
	Joining, missing addend	3	47	0	39
	Comparison	17	18	13	25
	Part-Part-Whole, missing addend	41	11	0	32
c-	Separating	27	13	0	39
	Joining, missing addend	1	53	0	34
	Comparison	12	26	0	30
	Part-Part-Whole, missing addend	28	15	0	33

strategy categories for each of the four subtraction problem types across the four levels. By this time, a large number of children have elected to use the mental operations of Number Facts (#F) or Heuristics (HU). Neither of these can be broken down into the additive, subtractive, or comparative categories. The number of children using mental operations is included in Table 16. For those who did not use mental operation strategies, semantic structure still appears to be a strong factor in the choice of strategy.

For Separating and Joining, missing addend, the correspondence between problem structure and strategy used is obviously very strong. While the use of the comparative (Matching) strategy with the Comparison problem is not as predominant, the argument for the influence of problem structure on strategy choice is still supported in that the Matching strategy appeared nowhere but in the Comparison problem. For those children who had the Matching strategy within their repertoire of problem-solving processes, the semantic structure of the Comparison problem was strong enough to evoke that strategy. Matching is virtually impossible without manipulatives, which accounts for the virtual absence of Matching at the b- and c- levels.

The data for the Part-Part-Whole, missing addend problem present a less clear picture. The most often used strategy at all levels is the subtractive one. Yet the overwhelming numerical difference between the subtractive and additive strategies that occurs in the Separating problem is not present for this problem. Of particular note is the contrast between subtractive and additive strategies at the c- level. In this situation there appears to be other factors determining the children's choice of strategy. A protracted discussion of what those factors might be is not appropriate for this report.

The "Mental" Strategies

Throughout the first one and one-half years of instruction that the children receive in class, the memorization of the number facts is encouraged. This fact is reflected in the high use of number facts and heuristics. In the addition problems, Tasks 1 and 4, Number Fact and Heuristic combined is the most common strategy used to solve the smaller number problems. In the subtraction problems, the "mental" strategies, Number Fact and Heuristic, are the first or second most commonly used set of strategies for the smaller number problems.

Less Frequently Occurring Strategies

During this fifth interview a number of the possible student response behaviors in somewhat isolated instances were observed. The two counting down strategies, Counting Down From and Counting Down To, appeared rather infrequently. However, in Task 2, Separating problem, the Counting Down From strategy was chosen at least 5% of the time, with the highest percentage, 11%, occurring at the c- level. This is consistent with results from previous interviews, showing that children apparently are associating counting down or backwards more often with the Separating task than with the Comparison or missing addend tasks.

Errors

No task was free of error, although the greater difficulty of the Comparison (Task 5) and the Part-Part-Whole, missing addend problems (Task 3) is reflected in the higher incidence of errors. Children's lack of comprehension of the structure of these two problems could be attributed as the cause for the cases in which one of the given numbers was supplied as the answer. Overall, miscounting was the most frequent error. This occurred

whether the children used cubes or their fingers or just counted mentally. A summary of the frequency of errors is presented in Table 17.

Secondary Analyses of Data

The data analyses contained in this section concern pupil performance rather than results for specific tasks as in the previous section. The patterns apparent in an individual student's response will be considered. In the first two subsections the relationship between a particular type of strategy or model employed and the correctness of response is examined. In the third section we will examine the consistency of a particular strategy across several tasks.

Relationship of Strategy Employed to Correctness of Response

The basic question of interest in this analysis is, "If a child employed a particular strategy, was the problem also solved correctly?" Data answering this question are presented in Tables 18 to 21, which aggregate information by levels b+, b-, c+, and c- respectively.

The results for the following behaviors do not appear in the tables because they are inappropriate to our discussion.

1. Number Fact. A requisite for coding Number Fact is that the child's response must be correct. There were 275 responses coded as Number Fact in b+, 309 in b-, 127 in c+, and 162 in c-.

2. ? or confusion. A requisite for this coding is that the child gives no answer; therefore it could not be coded right or wrong. There was 1 such response in level b+, 2 in b-, 0 in c+, and 7 in c-.

2. Uncodable. No strategy could be identified, even when the answer was correct. Of the 15 uncodable responses in level b+, 67% were correct; of the 21 uncodable responses in level b-, 29% were correct; of the 22

Table 17

Frequency of Errors Across the Six Problem Tasks

		Error Types					
Task	Level	Miscount	Forgets data	Use wrong operation	Given #	Guess	Interview terminated
1	b+	1	1	0	0	2	0
Joining	b-	0	0	0	1	0	0
	c+	7	0	0	0	2	0
	c-	3	1	0	0	3	2
2	b+	4	0	2	0	4	0
Separating	b-	1	2	0	1	4	0
	c+	5	0	0	0	10	0
	c-	7	1	0	2	4	2
3	b+	3	0	5	6	3	0
Part-Part-Whole, missing addend	b-	0	1	4	4	3	0
	c+	10	0	1	3	5	0
	c-	11	1	2	2	11	2
4	b+	0	1	0	0	1	0
Part-Part-Whole	b-	1	2	0	0	2	0
	c+	2	1	0	0	6	0
	c-	3	1	0	0	3	2
5	b+	6	3	6	5	0	0
Comparison	b-	1	1	5	7	4	0
	c+	5	1	7	4	5	0
	c-	5	1	4	4	10	2
6	b+	1	1	0	0	1	0
Joining, missing addend	b-	2	0	0	0	2	0
	c+	3	0	0	0	2	0
	c-	3	1	0	0	2	2

Table 18

Level b+: Number of Children Employing a Strategy and Their Rate of Success

Strategy	Task 1	2	3	4	5	6	Total
CS	4(75%)[a]	-	-	7(100%)	-	-	11(91%)
CL	21(95%)	-	-	25(96%)	-	-	46(96%)
CA	9(89%)	-	-	7(100%)	-	-	16(94%)
F	-	35(86%)	27(89%)	-	15(87%)	0	77(87%)
T	-	0	0	-	0	0	0
MA	-	0	0	-	9(67%)	0	9(67%)
AO	-	0	0	-	1(100%)	13(92%)	14(93%)
DF	-	5(80%)	6(83%)	-	1(0%)	0	12(75%)
UG	-	6(100%)	6(100%)	-	14(86%)	20(95%)	46(93%)
DT	-	0	0	-	0	0	0
HU	1(100%)	3(100%)	4(100%)	2(100%)	0	3(100%)	13(100%)
GU	2(0%)	4(50%)	3(0%)	1(0%)	0	1(0%)	11(18%)

[a]Numbers in parentheses give the percentage of the children in that cell who solved the problem task correctly

Table 19

Level b-: Number of Children Employing a Strategy and Their Rate of Success

Strategy	Task 1	2	3	4	5	6	Total
CS	9(100%)[a]	-	-	7(86%)	-	-	16(94%)
CL	15(100%)	-	-	18(94%)	-	-	33(97%)
CA	5(100%)	-	-	2(100%)	-	-	7(100%)
F	-	19(89%)	19(95%)	-	7(86%)	0	45(91%)
T	-	0	0	-	0	0	0
MA	-	0	0	-	2(100%)	0	2(100%)
AO	-	0	1(100%)	-	1(100%)	8(100%)	10(100%)
DF	-	5(100%)	4(100%)	-	2(100%)	0	11(100%)
UG	-	7(100%)	6(100%)	-	19(100%)	25(92%)	57(96%)
DT	-	0	0	-	0	0	0
HU	4(100%)	5(80%)	1(100%)	2(100%)	1(100%)	2(100%)	15(93%)
GU	0	4(0%)	3(0%)	2(0%)	4(0%)	2(0%)	15(0%)

[a]Numbers in parentheses give the percentage of the children in that cell who solved the problem task correctly

Table 20

Level c+: Number of Children Employing a Strategy and Their Rate of Success

Strategy	Task 1	2	3	4	5	6	Total
CS	13(77%)[a]	-	-	8(88%)	-	-	21(81%)
CL	30(87%)	-	-	32(94%)	-	-	62(90%)
CA	18(94%)	-	-	10(100%)	-	-	28(96%)
F	-	33(91%)	35(80%)	-	11(82%)	1(100%)	80(85%)
T	-	0	0	-	0	0	0
MA	-	0	0	-	13(85%)	0	13(85%)
AO	-	1(100%)	0	-	2(100%)	17(88%)	20(90%)
DF	-	8(75%)	5(80%)	-	6(100%)	2(100%)	21(86%)
UG	-	10(80%)	11(91%)	-	16(88%)	30(97%)	67(91%)
DT	-	3(100%)	1(100%)	-	0	0	4(100%)
HU	11(82%)	9(100%)	13(85%)	11(91%)	7(71%)	15(100%)	66(89%)
GU	2(0%)	10(0%)	5(0%)	6(0%)	5(0%)	2(0%)	30(0%)

[a]Numbers in parentheses give the percentage of the children in that cell who solved the problem task correctly

Table 21

Level c-: Number of Children Employing a Strategy and Their Rate of Success

Strategy	Task 1	2	3	4	5	6	Total
CS	9(56%)[a]	-	-	13(85%)	-	-	22(73%)
CL	30(90%)	-	-	28(89%)	-	-	58(90%)
CA	2(100%)	-	-	2(50%)	-	-	4(75%)
F	-	14(71%)	16(69%)	-	4(75%)	-	34(71%)
T	-	0	0	-	0	1(100%)	1(100%)
MA	-	0	0	-	0	0	0
AO	-	1(100%)	1(100%)	-	1(100%)	5(80%)	8(88%)
DF	-	11(73%)	10(50%)	-	8(75%)	0	29(66%)
UG	-	12(83%)	14(79%)	-	25(80%)	48(90%)	99(85%)
DT	-	2(50%)	2(100%)	-	0	0	4(75%)
HU	16(100%)	9(78%)	12(92%)	9(78%)	7(71%)	5(80%)	58(86%)
GU	3(0%)	4(0%)	11(0%)	3(0%)	10(0%)	2(0%)	33(0%)

[a]Numbers in parentheses give the percentage of the children in that cell who solved the problem task correctly

uncodable responses in level c+, 55% were correct; of the 31 uncodable responses in level c-, 48% were correct.

4. Wrong Operation. If the children used the wrong operation (for example, adding instead of subtracting), the answer was always incorrect. There were 13 responses in level b+ that were coded wrong operation, 9 in b-, 8 in c+, and 6 in c-.

5. Given Number. If a child responded with a number given in the problem, it was always an incorrect answer. There were 11 such responses in level b+, 13 in b-, 7 in c+, and 8 in c-.

The entries in Tables 18-21 present the number of children who used a certain strategy for a certain task. That number is followed by a percentage figure in parentheses, which represents the portion of those children using the strategy who also got the correct answer.

For example, in the example below, of the 4 children who used the counting up from smaller strategy for Task 1, 75% (which is to say, 3 of them) also solved the task correctly.

	Task	
Strategy	1	2
CS	4(75%)	-

In the example, a dash appears on the CS cell for Task 2. A dash indicates the strategy would be inappropriate for this task. In the example, CS is an addition strategy and thus was not coded for Task 2, a subtraction problem.

There is no clear cut pattern indicating that one particular strategy appears to be more successful than any other. The only one that uniformly

appears less successful is the counting down from (DF) strategy. This would suggest that accurate backward counting is still difficult for some children at this age level.

Relationship of Model Used to Correctness of Response

We also investigated the relationship between a particular modeling behavior and the rate of correct responses. Table 22-25 present the results. In the Model category the possible responses were cubes, fingers, no action, other (physical), or a combination of cubes and fingers. Uncodable model responses, confused responses, and combination of models other than cubes and fingers were not considered in the tabulation of these results.

The tables present the number of children who used a particular model for each task and the percentage of those children whose answer to the task was correct. As was the case with strategies, there is no definite pattern of success for a particular modeling behavior. Thus, no reliable conclusions can be drawn from these data.

Consistency of Student Response

We also investigated whether a child who exhibited a particular response on a problem task would tend to exhibit that behavior on another task. More specifically, does a child show a consistent pattern of response, exhibiting the same behavior every time it is appropriate? Such consistency of behavior could indicate a child's interpretation of the operation of addition or subtraction. If, in a given level, a child used an additive strategy consistently over all four subtraction tasks, such consistency could indicate that the child has formed an interpretation of subtraction that is independent of the structure of a problem.

Table 22

Level b+: Number of Children Employing a Model and Their Rate of Success

	Task						
Model	1	2	3	4	5	6	Total
Cubes alone	18(94%)[a]	29(90%)	26(73%)	20(95%)	27(67%)	17(94%)	137(84%)
Fingers alone	3(100%)	7(71%)	9(78%)	8(100%)	6(100%)	3(33%)	36(83%)
Cubes and Fingers	0	0	0	0	0	0	0
No action	75(95%)	60(90%)	61(80%)	68(99%)	62(82%)	76(100%)	402(92%)
Other	0	0	0	0	0	0	0

[a]Numbers in parentheses give the percentage of the children in that cell who solved the problem task correctly.

Table 23

Level b-: Number of Children Employing a Model and Their Rate of Success

	Task						
Model	1	2	3	4	5	6	Total
Cubes alone	NA	NA	NA	NA	NA	NA	NA
Fingers alone	17(94%)[a]	19(89%)	22(86%)	20(100%)	20(75%)	16(88%)	114(89%)
Cubes and Fingers	NA	NA	NA	NA	NA	NA	NA
No action	79(97%)	77(90%)	71(80%)	76(93%)	76(79%)	80(96%)	459(90%)
Other	0	0	1(100%)	0	0	0	1(100%)

[a]Numbers in parentheses give the percentage of the children in that cell who solved the problem task correctly.

Note: NA indicates the strategy is not applicable to this task.

Table 24

Level c+: Number of Children Employing a Model and Their Rate of Success

	Task						
Model	1	2	3	4	5	6	Total
Cubes alone	26(100%)[a]	34(91%)	31(77%)	17(100%)	26(69%)	21(86%)	155(86%)
Fingers alone	13(100%)	6(83%)	8(75%)	15(93%)	11(82%)	10(100%)	63(90%)
Cubes and Fingers	0	1(100%)	2(100%)	0	2(100%)	2(100%)	7(100%)
No action	57(79%)	55(76%)	55(78%)	64(83%)	57(67%)	62(94%)	350(80%)
Other	0	0	0	0	0	1(100%)	1(100%)

[a]Numbers in parentheses give the percentage of the children in that cell who solved the problem task correctly.

Table 25

Level c-: Number of Children Employing a Model and Their Rate of Success

Model	Task 1	2	3	4	5	6	Total
Cubes alone	NA	NA	NA	NA	NA	NA	NA
Fingers alone	24(79%)[a]	26(77%)	31(65%)	25(92%)	24(83%)	34(85%)	164(80%)
Cubes and Fingers	NA	NA	NA	NA	NA	NA	NA
No action	70(86%)	65(75%)	63(68%)	68(84%)	69(61%)	59(92%)	394(77%)
Other	0	1(0%)	0	0	0	1(0%)	2(0%)

[a]Numbers in parentheses give the percentage of the children in that cell who solved the problem task correctly.

Note: NA indicates the strategy is not applicable to this task.

Consistency is examined in two ways. In the first, behavior was summarized across all the tasks administered within a specific level. In the second analysis, consistency was considered for a single task across all the levels in which it appeared. The total population of 96 subjects was used in this analysis. In addition to considering use of model, correctness, and strategies, this analysis treated several combined strategies. The combined strategies represent similar patterns of thinking. The following combined strategies have been created for this analysis:

CE- The student responded either CL (Counts Up from Larger) or CS (Counts Up from Smaller).

SEP- The student responded either F (Separates From) or T (Separates To).

CTD- The student responded either DF (Counts Down From) or DT (Counts Down To).

SF- The student responded either F (Separates From) or DF (Counts Down From).

AD- The student responded either AO (Add On) or UG (Counts Up from Given).

ST- The student responded either T (Separates To) or DT (Counts Down To).

ADV- The student responded either with #F (Number Fact) or HU (Heuristic).

In general, the results show the following:

1. Overall, the children are somewhat consistent in the use of strategies for addition tasks. However, there is little consistency in the subtraction tasks across level, which is to be expected if, as indicated previously in this report, problem structure is a major determining factor in children's choice of strategy.

2. Children were more consistent in choice of strategy for the Separating and the Part-Part-Whole, missing addend tasks across levels than for the Comparison and the Joining, missing addend tasks.

The cases where children were consistent, that is, where 3 or more children

gave a response the maximum number of times possible, are detailed in Tables 26 and 27.

Conclusion

This is the fifth in a series of reports on the data from the individual interviews for the Coordinated Study. Each report contains data for only one round of interviewing, and is not concerned with results or changes across time. The longitudinal findings will be presented in separate reports. For subsequent and previous reports in the individual interview series and for additional information and reports concerning the longitudinal study, contact the Mathematics Work Group at the Wisconsin Research and Development Center for Individualized Schooling, Madison, Wisconsin.

Table 26

Number of Children Who Gave Response

Maximum Number of Times Across Tasks by Levels

Model or strategy	Maximum responses possible	Level			
		b+	b-	c+	c-
Cubes	6	8	NA	11	NA
Fingers	6	0	6	0	10
No action	6	46	62	35	47
Correct	6	54	58	40	35
CS	2	-	4	3	6
CL	2	13	9	17	18
CA	2	4	-	9	-
CE	2	18	13	26	29
DF	4	-	-	-	6
#F	6	18	24	8	8
ADV	6	20	27	11	18

Note: NA indicates the strategy is not applicable to this task.

- (hyphen) indicates that the number of children who gave a response the maximum number of times was less than three.

Table 27

Number of Children Who Gave Response

Maximum Number of Times Across Levels by Task

Model or strategy	Maximum responses possible	Task					
		1	2	3	4	5	6
Cubes	2	14	22	22	13	22	16
No action	4	48	39	43	49	43	48
Correct	4	71	50	44	69	40	73
CL	4	-	NA	NA	6	NA	NA
CA	4	3	NA	NA	-	NA	NA
CE	4	3	NA	NA	8	NA	NA
F	4	NA	10	10	NA	-	-
SEP	4	NA	10	10	NA	-	-
SF	4	NA	14	13	NA	3	-
DF	4	NA	-	-	NA	-	3
AD	4	NA	-	-	NA	-	12
#F	4	12	11	10	14	11	15
ADV	4	22	17	16	22	18	24

Note: NA indicates the strategy is not applicable to this task.

- (hyphen) indicates that the number of children who gave a response the maximum number of times was less than three.

Reference Notes

1. Kouba, V.L. & Moser, J.M. Development and validation of curriculum units related to initial sentence writing (Technical Report No. 522) Madison: Wisconsin Research and Development Center for Individualized Schooling, October, 1979.

2. Kouba, V.L. & Moser, J.M. Development and validation of curriculum units related to learning of addition and subtraction algorithms (Working Paper No. 287) Madison: Wisconsin Research and Development Center for Individualized Schooling, 1980.

3. Moser, J.M. Young children's representation of addition and subtraction problems (Theoretical Paper No. 74) Madison: Wisconsin Research and Development Center for Individualized Schooling, May 1979.

4. Carpenter, T.P. & Moser, J.M. An investigation of the learning of addition and subtraction (Theoretical Paper No. 79) Madison: Wisconsin Research and Development Center for Individualized Schooling, November 1979.

5. Martin, C. & Moser, J.M. Interviewer training procedures (Working Paper) Madison: Wisconsin Research and Development Center for Individualized Schooling, 1980.

6. Cookson, C. & Moser, J.M. Coordinated study individual interview procedures (Working Paper No. 290) Madison: Wisconsin Research and Development Center for Individualized Schooling, 1980.

7. Carpenter, T.P., Hiebert, J. & Moser, J.M. The effect of problem structure on first-graders' initial solution processes for simple addition and subtraction problems (Technical Report No. 516) Madison: Wisconsin Research and Development Center for Individualized Schooling, 1979.

References

Gibb, E.H. Children's thinking in the process of subtraction. Journal of Experimental Education, 1956, 25, 71-80.

Romberg, T.A., Harvey, J.G., Moser, J.M. & Montgomery, M.E. Developing Mathematical Processes. Chicago: Rand McNally and Co., 1974.

APPENDIX A

PROBLEM TASKS BY LEVEL

b+

1. Addition - simple joining

Wally had ___ pennies.

His father gave him ___ more pennies.

How many pennies did Wally have altogether?

b+

2. Subtraction - simple separating

Tim had ___ candies.

He gave ___ candies to Martha.

How many candies did Tim have left?

b+

3. Subtraction - part, part, whole missing addend

There are ___ children on the playground.

___ are boys and the rest are girls.

How many girls are on the playground?

b+

4. Addition - part, part, whole

Sara has ___ sugar donuts.

She also has ___ plain donuts.

How many donuts does Sara have altogether?

b+

5. Subtraction - difference

Joe has ___ balloons.

His sister Connie has ___ balloons.

How many more balloons does Connie have than Joe?

b+

6. Subtraction - simple joining missing addend

Kathy has ___ pencils.

How many more pencils does she have to put with them so she has ___ pencils altogether?

b-

1. Addition - simple joining

Fred had ___ stamps.

His mother gave him ___ more stamps.

How many stamps did Fred have altogether?

2. Subtraction - simple separating

Joan had ___ apples.

She gave ___ apples to Louise.

How many apples did Joan have left?

3. Subtraction - part, part, whole missing addend

There are ___ cookies on a plate.

___ are oatmeal and the rest are chocolate.

How many chocolate cookies are on the plate?

4. Addition - part, part, whole

Judy has ___ white stuffed animals.

She also has ___ brown stuffed animals.

How many stuffed animals does Judy have altogether?

5. Subtraction - difference

Mike has ___ kites.

His sister Kathy has ___ kites.

How many more kites does Kathy have than Mike?

6. Subtraction - simple joining missing addend

Joe has ___ pet fish.

How many more fish does he have to put with them so he has ___ fish altogether?

c+

1. Addition - simple joining

Sue had oranges.

Her mother gave her more oranges.

How many oranges did Sue have altogether?

c+

2. Subtraction - simple separating

Sally had rocks.

She gave rocks to Don.

How many rocks did Sally have left?

c+

3. Subtraction - part, part, whole missing addend

There are dogs in the park.

are big and the rest are little.

How many little dogs are in the park?

c+

4. Addition - part, part, whole

Don saw tigers.

He also saw elephants.

How many animals did he see altogether?

c+

5. Subtraction - difference

Jennifer has puzzles.

Her friend Ed has puzzles.

How many more puzzles does Ed have than Jennifer?

c+

6. Subtraction - simple joining missing addend

Susan has books.

How many more books does she have to put with them so she has books altogether?

c-

1. Addition - simple joining

Steve had ___ fish.

His friend gave him ___ more fish.

How many fish did Steve have altogether?

c-

2. Subtraction - simple separating

Diane had ___ marbles.

She gave ___ of them to Laura.

How many marbles did Diane have left?

c-

3. Subtraction - part, part, whole missing addend

There are ___ bikes in the yard.

___ are red and the rest are green.

How many green bikes are in the yard?

c-

4. Addition - part, part, whole

Jamie has ___ silver airplanes.

She also has ___ blue airplanes.

How many airplanes does Jamie have altogether?

c-

5. Subtraction - difference

Karl has ___ cards.

His friend Tony has ___ cards.

How many more cards does Tony have than Karl?

c-

6. Subtraction - simple joining missing addend

Mark has ___ candy bars.

How many more candy bars does he have to put with them so he has ___ candy bars altogether?

APPENDIX B

INDIVIDUAL STUDENT PROFILES

101	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y HU -	N Y #F -	N Y #F -	N Y #F -	N Y HU -
b-	N Y #F -	N N GI GI	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y CL -	N Y HU -	N Y HU -	N Y HU -	N Y HU -	N Y #F -
c-	N Y HU -	N N DF M	N N GU -	- ? ? -	N Y #F -	N Y #F -
102	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Task 6**
b+	N Y #F -	N Y #F -	F N OP O	N Y #F -	N N OP O	N Y #F -
b-	N Y HU -	N Y #F -	N N OP O	N Y #F -	N N OP O	N Y #F -
c+	N Y #F -	N N GU -	N N GU -	F Y CS -	F N OP O	F Y UG -
c-	N Y CL -	N Y #F -	N N UN -	N Y #F -	N N GU -	F Y UG -
103	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Task 6**
b+	N Y #F -	F Y F -	F Y UG -	F Y CL -	F Y F -	N Y #F -
b-	F Y S -	F Y F -	F Y F -	F Y CL -	F Y UG -	N Y #F -
c+	F Y CS -	C Y F -	C N F M	F Y CL -	C Y AO -	C Y AO -
c-	F Y CL -	F Y F -	F N F -	F Y CL -	F Y UN -	F Y UG -
104	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Task 6**
b+	N Y #F -	N N OP O	C Y F -	N Y CL -	C Y F -	N Y UG -
b-	N Y CL -	F Y F -	F Y F -	F Y CL -	N N GI GI	N N UG M
c+	N Y CL -	C Y F -	C Y F -	N Y CL -	C Y F -	N Y UG -
c-	N Y CL -	N Y DF -	F N F M	N N CI M	N Y DF -	N Y UG -

105	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	F Y CS -	N Y #F -	F Y F -	F Y CS -	N Y #F -	F N AO F
b-	F Y CS -	N Y #F -	F Y F -	N N GU -	N N GI GI	N Y #F -
c+	N Y CS -	N Y DF -	F Y F -	F Y CS -	F Y F -	N N UN -
c-	N N UN F	N Y UN -	F Y F -	N N UN -	F Y UG -	F N UN -

106	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	F N F -	N N DF -	N Y CS -	N Y #F -	N Y UG -
b-	N Y CS -	F Y F -	F N F -	N N UN F	N Y UG -	N Y UG -
c+	N N CS M	C Y F -	C Y F -	N Y CL -	N Y DF -	N Y UG -
c-	N N CL M	F Y F -	N Y DF -	N N CL F	N Y UG -	N Y UG -

107	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	C Y F -	C Y F -	C Y CL -	C Y AO -	C Y AO -
b-	F Y CL -	F Y F -	F Y F -	F Y CA -	F Y AO -	N Y #F -
c+	C Y CA -	C Y F -	C Y F -	C Y CL -	C Y MA -	C Y AO -
c-	N Y #F -	N Y DF -	N N DF M	N Y CL -	N Y DF -	N Y UG -

108	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CA -	C Y F -	C N F M	F Y CS -	C Y MA -	C Y AO -
b-	F Y CS -	F Y F -	F Y F -	F Y CS -	F N F M	F Y AO -
c+	C Y CA -	C Y F -	C N F M	C Y CA -	C Y MA -	C Y AO -
c-	F N CS M	F N GU -	F N GU -	F Y CS -	F Y UG -	F N UG F

109	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	F Y S -	F Y F -	N N GI GI	F Y S -	C N GI GI	C N GU -
b-	F Y S -	F Y F -	F N GI GI	F Y S -	N N GI GI	F Y AO -
c+	C Y CL -	C Y F -	C Y F -	C Y CL -	C N GI GI	C Y AO -
c-	F Y CA -	C Y AO -	F N F M	F Y UN -	N N GI GI	F Y AO -
110	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CL -	N Y #F -	C Y F -	C Y CL -	C Y F -	C Y AO -
b-	N Y CL -	N N HU -	F Y F -	F Y S -	F Y F -	F Y AO -
c+	C Y CS -	C Y F -	C N F M	F Y CL -	C N F M	C Y AO -
c-	F Y CS -	N N DT M	F Y F -	F Y CL -	F Y F -	F Y UG -
111	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N N GU -	N Y CL -	F Y F -	N Y #F -
b-	F Y CA -	N Y #F -	N Y #F -	F Y S -	F N GU -	N Y #F -
c+	F N CS -	N N GU -	C N F M	N N GU -	C Y MA -	N Y UG -
c-	N Y #F -	F Y F -	F Y F -	N Y CL -	F N F -	N Y HU -
112	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N N GU -	N Y DF -	N Y #F -	N Y CS -	N N OP O	N Y UG -
b-	N Y CL -	N Y DF -	N Y DF -	N Y CL -	N Y UG -	N Y UG -
c+	F Y CL -	F Y DF -	F Y DF -	N Y CL -	F Y DF -	F Y DF -
c-	F Y CL -	F Y DF -	F N DF -	F Y CL -	F Y DF -	N Y #F -

113	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N N GI GI	N Y #F -	C Y MA -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	F Y UG -	N Y #F -
c+	N Y CL -	N Y DF -	C Y F -	N Y CL -	C N MA M	N Y #F -
c-	N Y HU -	N Y HU -	N Y HU -	N Y CS -	N N UN -	N Y #F -

114	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	C Y F -	C Y F -	C Y S -	C Y MA -	C Y AO -
b-	F Y CS -	F Y F -	F Y F -	F Y S -	F Y MA -	F Y #F -
c+	F Y CS -	F Y DT -	C Y F -	C Y CA -	C N UN -	C Y F -
c-	F Y CS -	F ? ? -	F N UN -	F Y CS -	F Y UG -	F Y UG -

115	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y UG -
b-	N Y #F -	N Y #F -	N N GU -	N Y #F -	F Y UN -	N Y #F -
c+	N Y CL -	N Y DF -	N Y DF -	N Y #F -	N Y DF -	N Y UG -
c-	N N UN -	N N GI GI	N Y UG -	N Y CS -	N N DF -	F Y UG -

116	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CA -	C Y F -	C Y F -	C Y CS -	C Y F -	C Y #F -
b-	F Y CA -	F Y F -	F Y F -	F Y CS -	F Y F -	F Y #F -
c+	C Y CS -	C Y F -	C Y F -	F Y CS -	C Y F -	F Y UG -
c-	F Y CS -	F Y F -	F N F M	F Y CS -	F N UG M	F Y UG -

117	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y HU -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N N HU -	N Y #F -	N Y HU -	N Y HU -	N Y HU -	N Y HU -
c-	N Y HU -	N N HU -	N Y HU -	N Y HU -	N Y HU -	N Y #F -

118	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N N GU F	N Y #F -

119	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CA -	C Y F -	C Y F -	C Y CL -	- ? ? -	C Y AO -
b-	F Y S -	F Y F -	F Y F -	F Y S -	F N OP O	F Y AO -
c+	C Y CA -	C Y F -	C Y F -	C Y CA -	N N OP O	C N AO M
c-	F Y CA -	F Y F -	F Y F -	F Y CA -	N N GU -	F Y AO -

120	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N N GU -	N Y #F -	N Y UN -	N Y UN -	N Y #F -
b-	N Y UN -	N Y UN -	N N GU -	N Y #F -	N Y #F -	N Y #F -
c+	F Y CS -	N Y UN -	N Y UN -	N Y CL -	N N UN -	N Y HU -
c-	N Y CL -	N Y DF -	N Y HU -	N Y HU -	N Y #F -	F Y UG -

121	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CA -	C Y F -	C Y F -	C Y CA -	C Y F -	C Y AO -
b-	F Y CA -	F Y F -	F Y F -	N Y #F -	F Y F -	F Y AO -
c+	C Y CA -	C Y F -	C Y F -	C Y CS -	C N F F	C Y UG -
c-	F Y CL -	- ? ? -	F N UG M	F Y CL -	F Y UG -	F Y UG -

123	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y DF -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y HU -	N Y #F -	N Y #F -	N Y HU -	N Y #F -
c+	N Y HU -	C N F M	N Y HU -	N N CL M	N Y UG -	N Y #F -
c-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N N UG M	N Y #F -

124	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	C Y F -	F Y F -	N Y #F -	C Y F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y DF -	F Y CL -	N Y #F -	N Y #F -
c+	C Y CA -	C Y F -	C Y F -	F Y CL -	C Y MA -	F Y UG -
c-	F Y CL -	N Y HU -	N Y HU -	N Y HU -	F Y UG -	F Y UG -

125	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CA -	C Y F -	C N F M	C Y CA -	N Y UG -	C Y AO -
b-	F Y CS -	F Y F -	F Y F -	F Y CS -	N Y UG -	N Y UG -
c+	C Y CA -	C Y F -	C N F M	C Y CA -	C Y MA -	C Y AO -
c-	F Y CS -	F Y F -	F Y F -	F Y CS -	F Y UG -	F Y UG -

127	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	N Y UG -	N Y HU -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y HU -	N Y UG -	N Y HU -	N Y UG -	N Y UN -
c+	F Y CL -	F N DF M	F N DF M	F Y CL -	F Y DF -	C Y AO -
c-	F Y CL -	F Y DF -	F Y DF -	F Y CL -	F N DF M	F Y UG -

128	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y UN -	C N UN -	C N CL F	F Y UG -	N Y #F -
b-	N Y HU -	N Y UG -	N N UN -	N Y #F -	F Y UG -	N Y UG -
c+	N Y CL -	N Y DT -	N N GI GI	F Y CL -	F Y UG -	F Y UG -
c-	N Y HU -	F Y UG -	N N GI GI	N Y CS -	F Y UG -	F Y UG -

129	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CS -	C Y F -	C Y F -	C Y CL -	N Y UG -	N Y UG -
b-	N Y CL -	N Y HU -	N Y UG -	N Y CL -	N Y UG -	N Y UG -
c+	N Y #F -	N N GU -	N Y #F -	N Y #F -	F Y UG -	N Y #F -
c-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -

130	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -

131	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y #F -	C N F M	C Y F -	C Y CA -	C N MA M	C Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y UG -
c+	C Y CA -	C Y F -	C Y F -	C Y CS -	C Y MA -	C Y AO -
c-	F N CS M	N N GU -	N N UG M	F Y UN -	F Y UG -	N Y #F -

132	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	F Y #F -	N N GU -	N Y HU -	N Y #F -	N Y HU -	N Y #F -
c-	Y #F -	F Y F -	F Y AO -	N Y #F -	N Y #F -	F Y AO -

133	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CA -	C Y F -	C N UN -	C Y CA -	C N GI GI	C Y AO -
b-	F Y CA -	F Y F -	- ? ? -	F Y CA -	F N GI GI	F Y AO -
c+	C Y CA -	C Y F -	N N OP O	F Y CA -	N N GI GI	C Y AO -
c-	F ? ? -	O N F -	F N OP O	F N UN -	N N GI GI	F N AO M

134	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N N CS -	N Y UN -	N N GU -	N Y CL -	N N OP O	N Y UG -
b-	N Y #F -	N Y #F -	N N OP O	N Y #F -	N N OP O	N Y UG -
c+	N N CS M	N N GU -	N N GU -	N N UN -	N N GU -	N Y UN -
c-						

135	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C N CA F	C Y F -	C Y F -	C Y CA -	C N OP O	C Y AO -
b-	N Y CL -	N N UN -	N N UN -	N Y UN -	N N OP O	N Y #F -
c+	C Y CA -	C Y F -	C Y F -	C Y CA -	C N OP O	C Y UN -
c-	N Y HU -	N Y #F -	N N OP O	N Y CL -	N N OP O	N Y UG -

137	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CL -	C Y F -	C Y F -	C Y CL -	C Y MA -	C Y UG -
b-	N Y #F -	F Y F -	F Y AO -	N Y #F -	F Y UG -	F Y AO -
c+	C Y CL -	C Y F -	C Y F -	C Y CL -	C Y F -	C Y UG -
c-	F Y CL -	F Y UG -	F Y UG -	F Y CL -	F Y UG -	F Y UG -

139	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	F Y F -	F Y F -	N Y #F -	F Y UG -	F N UG M
b-	F Y CS -	F Y F -	F Y F -	F Y S -	F Y MA -	F Y UG -
c+	F Y CL -	C Y F -	C Y F -	N Y UN -	C Y AO -	C Y AO -
c-	F Y CL -	F Y F -	F Y F -	F Y CS -	N Y UN -	F Y AO -

140	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	C Y F -	N N GI GI	N Y #F -	N N GI GI	N Y UG -
b-	N Y #F -	N Y DF -	N Y DF -	N Y #F -	N N GI GI	N Y HU -
c+	N Y CL -	N N DF -	C Y F -	N Y CL -	N N GI GI	N Y UG -
c-	N Y CL -	N N DF -	N Y DF -	N N CL -	N N GI GI	N Y UG -

141	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	N Y UN -	N Y DF -	N Y CL -	N N DF M	N Y UG -
b-	N Y CL -	N Y #F -	N N GU -	N N CL F	N Y UN -	N Y UG -
c+	N N CL -	N N GU -	N N GI GI	N N UN -	N N UN -	N Y UG -
c-						

143	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	C Y F -	C Y F -	N Y #F -	C N F M	N Y #F -
b-	N Y #F -	N Y DF -	O Y F -	N Y #F -	M Y DF -	M Y #F -
c+	C Y CL -	C Y F -	C N F M	N Y #F -	C Y MA -	N N UG M
c-	N Y #F -	N N UN -	F Y UN -	N Y #F -	F Y F -	F N UG M

144	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	F Y F -	F Y F -	F Y S -	F Y UN -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	C Y CS -	N Y UG -	N Y HU -	N Y HU -	N Y UG -	N Y UG -
c-	N Y CL -	N N UG -	N Y #F -	N Y #F -	N N UG -	N Y HU -

147	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CL -	N Y #F -	N Y #F -	N Y #F -	N Y UG -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	F Y CL -	F Y UG -	F Y UG -	F Y CL -	N Y HU -	F Y UG -
c-	F Y CL -	F Y UG -	F Y UG -	F Y CL -	F Y UG -	F Y UG -

148	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	N Y #F -	N Y UG -	N Y #F -	N Y #F -	N Y #F -
c-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -

151	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CA -	C Y F -	F N UN -	F Y CS -	F Y UG -	F Y UG -
b-	F Y CS -	F Y F -	F N UN -	F Y CS -	F Y UG -	F Y UG -
c+	C Y CA -	C Y F -	C Y UG -	N N GU -	N N UN -	N Y DF -
c-	F N UN -	N N UN -	N N GU -	N N GU -	N N GU -	O N UN -

152	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CL -	C Y F -	C Y F -	C Y CS -	C Y F -	C Y AO -
b-	F Y S -	F N F M	F Y F -	F Y S -	F Y F -	N Y #F -
c+	C Y CA -	C Y F -	C Y F -	C Y CL -	C N MA M	C Y AO -
c-	F Y CS -	F N F M	F Y F -	F Y CS -	F Y AO -	N N UG M

153	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N N CL M	C Y F -	N Y #F -	N Y CL -	C N MA M	N Y UG -
b-	N Y #F -	N Y #F -	N Y UG -	N Y CL -	N Y UG -	N Y UG -
c+	N Y HU -	N Y UG -	N Y UG -	N Y HU -	C Y MA -	N Y HU -
c-	N Y CL -	N N GU -	N N GU -	N Y CL -	N N HU -	N N UG -

154	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y UN -	N N DF -	N N OP O	N Y UN -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N N OP O	N Y #F -	N Y #F -	N Y UG -
c+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c-	N Y #F -	N Y #F -	N N GU -	N Y #F -	N Y #F -	N Y UG -

155	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	N Y #F -	N Y #F -	N Y #F -	N Y UG -	N Y #F -
b-	N Y #F -	N N UN -	N N GI GI	N Y #F -	N Y #F -	N Y #F -
c+	F Y CS -	N N UG -	N N UN -	N N CS -	N Y UG -	N Y HU -
c-	N N CL -	N Y HU -	N N HU F	N N CS -	N Y UG -	F N UG -

158	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	C N F M	C Y F -	C Y CL -	C N MA F	C Y UG -
b-	N Y #F -	F Y F -	F Y F -	F Y CS -	F Y F -	N N GU -
c+	C Y CL -	C Y F -	C Y F -	C Y CL -	C Y MA -	C Y UG -
c-	N Y HU -	F N F M	F Y F -	F N CA M	- ? ? -	F Y UG -

159	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	N Y UG -	N Y UG -	F Y CL -	N Y UG -	N Y #F -
b-	N Y HU -	N Y UG -	N Y UG -	N Y #F -	N Y UG -	N Y UG -
c+	N N HU -	N N UG M	F N UG N	F Y CL -	F Y DF -	F Y UG -
c-	Y N CL -	F Y UG -	F Y UG -	N N HU -	F Y UG -	F Y UG -

160	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N N GU -	F Y DF -	N Y UN -	N Y #F -	N Y UG -	N Y #F -
b-	N Y HU -	N Y HU -	N Y HU -	N Y HU -	N Y #F -	N Y #F -
c+	N Y #F -	N N GU -	N Y UG -	N Y CL -	N Y UG -	N Y UG -
c-	N Y CL -	N N UN -	N N UG M	N Y CL -	N Y UG -	N Y UG -

162	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y UG -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	F Y F -	N Y #F -	N Y CL -	N Y UG -	N Y #F -
c+	N Y HU -	N Y HU -	N Y #F -	N Y CL -	N N OP O	N Y HU -
c-	N Y HU -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -

163	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	F Y CL -	N Y #F -	F Y UG -	N Y CL -	N Y UG -	N Y #F -
b-	N Y CL -	N Y UG -	N Y UG -	N Y #F -	N Y UG -	N Y #F -
c+	N Y #F -	N Y #F -	N Y #F -	N N GU -	N Y #F -	N Y #F -
c-	N Y #F -	N Y UG -	N Y #F -	N Y CL -	N Y #F -	N Y UG -

164	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	C Y F -	N Y #F -	F Y CL -	N Y #F -	N Y UG -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y UG -	N Y #F -
c+	F Y CL -	C Y F -	F Y F -	F Y CL -	F Y F -	C N AO M
c-	F Y CL -	N Y HU -	F Y F -	F Y CL -	N Y HU -	F Y UG -

165	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	C Y F -	C Y F -	C Y CA -	N N GI GI	N Y #F -
b-	N Y CS -	F N F F	N Y #F -	N N CS M	N N GI GI	N Y UG -
c+	C Y CA -	C Y F -	C Y F -	C Y CA -	N N GI GI	C Y AO -
c-	N N CS -	F Y F -	F Y F -	F Y CS -	N N GI GI	F Y UG -

166	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y UG -	N Y #F -	N Y CL -	N Y #F -	N Y #F -
b-	N Y CL -	N Y #F -	N Y #F -	N Y CL -	N Y UG -	F Y UG -
c+	F Y CL -	C Y F -	F Y F -	F Y CL -	F Y F -	F Y UG -
c-	F Y CL -	F Y F -	F Y F -	F Y CL -	F Y F -	F Y UG -

167	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y DF -	N Y DF -	N Y #F -	C Y F -	C Y #F -
b-	N Y #F -	N Y #F -	F Y F -	F Y CL -	N N GI GI	N Y #F -
c+	N Y CL -	C Y F -	N N GU -	N N HU F	N N OP O	N Y #F -
c-	N Y #F -	N Y DF -	F N DF M	N Y #F -	N N OP O	N Y UN -

168	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	N Y UG -	N Y UG -	N Y CL -	N N OP O	N Y #F -
b-	N Y CL -	N Y UG -	N Y UG -	N Y CL -	N N OP O	N Y UG -
c+	N N GU -	N Y #F -	N Y UG -	N Y #F -	N N OP O	N Y #F -
c-	N N GU -	N Y #F -	N Y #F -	N N GU -	N N OP O	N Y UG -

169	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	C Y F -	C Y F -	C Y CL -	C Y F -	C Y AO -
b-	N Y #F -	N Y #F -	F Y F -	N Y #F -	F Y F -	F Y AO -
c+	C Y CL -	C Y F -	C Y F -	C Y CL -	C Y DF -	C Y AO -
c-	N Y HU -	F Y DF -	F Y DF -	F Y CL -	F Y DF -	F Y UG -

170	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CS -	C Y F -	C N GI GI	C Y CA -	C Y F -	C Y AO -
b-	N N GI GI	N N GU -	N N GI GI	N N GU -	N Y #F -	N Y #F -
c+	C Y CA -	C N F M	C Y F -	C Y CA -	N N UN -	C N UN -
c-	N N GU -	N N GI GI	N N GU -	N N GU -	N N GU -	N N GU -

171	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CL -	N Y DF -	N Y DF -	N Y CL -	N Y #F -	N Y HU -
b-	N Y CL -	N Y #F -	N Y #F -	N Y CL -	N N UN F	N Y UG -
c+	N N CL M	C Y F -	N Y HU -	N Y CL -	N N HU -	N Y HU -
c-	N Y CL -	N N HU -	N Y HU -	N Y CL -	F ? ? -	F Y T -

172	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y UG -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	F Y UG -	N Y UG -	N Y #F -	F N UG M	F Y UG -
c-	N Y #F -	F Y UG -	F Y UG -	N Y #F -	F Y UG -	F Y UG -

93

173	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y S -	C Y F -	N Y #F -	N Y #F -	C Y F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y UG -
c+	C Y CA -	N Y HU -	N Y HU -	F N CL M	C Y MA -	N Y HU -
c-	N Y CL -	N N UG M	N Y HU -	N Y HU -	N Y #F -	F Y UG -

175	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y HU -	N Y #F -	N N OP O	N Y HU -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N N OP O	N Y #F -	N Y #F -	N Y #F -
c+	N Y CS -	N Y DT -	N Y DT -	N Y HU -	N Y #F -	N Y HU -
c-	N Y #F -	N Y #F -	N Y HU -	N Y HU -	N Y HU -	N Y #F -

177	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	F N F M	F Y F -	N Y CL -	N N UN -	N Y UG -
b-	F N UN -	N Y #F -	F Y F -	N Y CL -	F N UN -	F N UN -
c+	N N CL M	N Y #F -	C Y F -	N Y #F -	N Y #F -	N Y UG -
c-	N N CS -	F N F M	F N F M	N Y #F -	N Y #F -	N Y UG -

301	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	N Y UG -	N Y #F -	N Y #F -	N Y UG -	N Y #F -
c-	N Y CL -	N Y #F -	N Y UG -	N Y #F -	N N UG M	N Y #F -

302	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	N Y HU -	N Y #F -	N Y #F -	N N GU -	N Y #F -
c-	N Y HU -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -

303	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	N Y #F -	N Y #F -	N Y GU -	N Y #F -	N Y #F -
c-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -

304	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y HU -	C Y F -	N Y #F -	C Y F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	C Y CA -	C Y F -	N Y HU -	C Y CA -	N Y #F -	N Y HU -
c-	N Y #F -	N Y HU -	N N GU -	N Y UN -	N N GU -	N Y #F -

305	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y HU -	N Y HU -	N N GU -	N Y HU -	N Y #F -	N Y HU -
c-	N Y HU -	N Y #F -	N Y HU -	N Y HU -	N Y HU -	N Y HU -

306	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F –	N Y #F –	C N GI GI	N Y #F –	C N GI GI	N Y #F –
b-	N Y #F –	N N GU –	– ? ? –	F Y CS –	N N GU –	F N UG M
c+	C Y CA –	C N F M	C N F M	C Y CA –	C N OP O	F Y UN –
c-	F Y UN –	F N UN F	N N GU –	N Y UN –	N N OP O	N Y UN –

307	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F –	N Y HU –	N Y HU –	N Y #F –	N N UG M	N Y #F –
b-	N Y #F –	N N GU –	N Y #F –	N Y #F –	N Y #F –	N Y #F –
c+	N Y CL –	N Y HU –	N Y HU –	N Y HU –	N Y UG –	N Y #F –
c-	N Y UN –	N Y HU –	N Y HU –	N Y #F –	N Y UG –	N Y #F –

308	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –
b-	N Y #F –	N N GU –	N Y #F –	N Y #F –	N Y #F –	N Y #F –
c+	N Y CL –	N N GU –	N Y DF –	N Y #F –	N N GU –	N Y UG –
c-	N Y CL –	N Y #F –	N N DF M	N Y CL –	N N GU –	N Y #F –

309	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y UN –	C N F M	C N F M	C Y S –	C Y MA –	N Y #F –
b-	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N N GU –	N Y #F –
c+	N Y CL –	C Y F –	C Y F –	N Y #F –	C Y MA –	C Y AO –
c-	N Y CL –	– ? ? –	N Y UG –	F Y CS –	N Y UG –	N Y HU –

310	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	C Y F -	N Y HU -	N Y CL -	N Y #F -	N Y UG -
b-	N Y CL -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	F Y CL -	N N GU -	N Y DF -	N Y #F -	N Y UN -	C Y AO -
c-	N Y HU -	N N GU -	N N GU -	F Y CL -	N Y UN -	N Y #F -
311	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Task 6**
b+	N Y #F -	N Y UG -	N Y #F -	N Y CL -	N N UG F	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y CL -	N Y UG -	N Y #F -
c+	N Y CL -	N Y UG -	N Y UG -	N Y CL -	N Y UG -	N Y UG -
c-	N Y CL -	N Y UG -	N Y UG -	N Y CL -	N Y UG -	N Y UG -
312	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Task 6**
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c-	N Y HU -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
313	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Task 5**	**Task 6**
b+	N Y CL -	N Y UG -	N Y #F -	N Y CL -	N Y UG -	N Y UG -
b-	N Y #F -	N Y UG -	N Y #F -	N Y #F -	N Y UG -	N Y #F -
c+	N Y CL -	N Y DF -	N Y #F -	N Y CS -	C Y F -	N Y UG -
c-	N Y #F -	N Y UG -	N Y UG -	N Y CL -	N Y UG -	N Y UG -

314	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -

315	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N N OP O	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y HU -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y HU -
c-	N Y #F -	N Y #F -	N Y #F -	N Y HU -	N Y #F -	N Y #F -

316	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -

318	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	C Y CA -	C Y F -	C Y F -	C Y CL -	C Y MA -	N Y UG -
b-	N Y CA -	N Y DF -	N N UN -	N Y CL -	N Y UG -	N Y UG -
c+	N N CS M	C Y F -	C Y F -	N Y CL -	N Y UG -	N N UG -
c-	N Y HU -	N N DF M	N N DF M	N Y CL -	N N UG M	N Y UG -

319	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	C Y F -	C Y F -	N Y #F -	C N F M	N Y UG -
b-	N Y CS -	N Y DF -	F Y DF -	N Y #F -	N Y DF -	N Y UG -
c+	C Y CA -	C Y AO -	C Y F -	N Y CL -	C Y F -	N Y UG -
c-	N Y CL -	N Y DT -	N Y DT -	N N CS M	N Y DF -	N Y UG -

320	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y UG -	N Y UG -
b-	N Y CL -	N Y UG -	N Y #F -	N Y CL -	N Y #F -	N Y UG -
c+	N Y #F -	N Y #F -	N Y UG -	N Y #F -	C Y F -	N Y HU -
c-	N Y CL -	N Y #F -	N Y DF -	N Y #F -	N Y DF -	N Y UG -

321	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y HU -	F Y UG -	N Y #F -	F Y CL -	N Y #F -	N Y #F -
c-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N N GU -	F Y UG -

322	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y GU -	N Y UG -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y CL -	N Y UG -	C Y F -	N Y CL -	N Y UG -	N Y UG -
c-	N Y CL -	N Y UG -	N Y UG -	N Y CL -	N N GU -	N Y UG -

323	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	C Y F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y HU -	N Y #F -	N N HU -	N Y HU -	N N HU -	O Y UG -
c-	N Y #F -	N Y #F -	N Y UG -	N Y #F -	N N HU -	N N HU -

325	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	F Y CL -	N Y #F -	N N UN F	F Y CL -	N N UN -	F Y UG -
c+	C Y UN -	C Y UN -	F Y UG -	N Y CS -	F Y UG -	N Y UG -
c-	F Y CL -	F Y UG -	F Y DT -	F Y CL -	F Y UG -	F Y UG -

327	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N N GU -	N N GU -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y UG -

328	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y GU -	N N GI GI	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N N GI GI	N Y CL -	N N UN -	N Y #F -
c+	N Y #F -	N Y DF -	N N GI GI	N N GU -	N N UG M	N Y UG -
c-	N Y #F -	N Y DF -	N N GI GI	N Y #F -	N N GU -	N Y UG -

329	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL –	N Y #F –	N Y HU –	N Y #F –	N Y #F –	N Y #F –
b-	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y HU –
c+	N Y HU –	N Y HU –	N N HU M	N Y HU –	N Y HU –	N Y HU –
c-	N Y HU –	N Y #F –	N Y HU –	N Y #F –	N Y HU –	N Y #F –
330	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F –	N N UN –	N N OP O	N Y #F –	N N OP O	N Y #F –
b-	N N UN –	N Y #F –	N Y #F –	N Y #F –	N N GU –	N N GU –
c+	N N GU –	N Y #F –	N N GU –	N Y UN –	N Y UN –	N N GU –
c-	N N UN –	N Y UN –	N N GU –	N Y #F –	N Y UN –	N Y #F –
331	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –
b-	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –
c+	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –
c-	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –
332	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –
b-	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –	N Y #F –
c+	N Y CL –	N Y HU –	N Y HU –	N Y HU –	N Y UG –	N Y HU –
c-	N Y HU –	N Y HU –	N Y #F –	N Y HU –	N Y #F –	N Y #F –

333	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y HU -	N Y #F -	N Y #F -	N Y #F -	N N GU -	N Y #F -
c-	N Y #F -	N Y #F -	N Y HU -	N Y #F -	N Y #F -	N Y #F -

334	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y CL -	N Y #F -	N Y DF -	N Y HU -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y UG -
c+	N N CL M	N Y HU -	N Y HU -	N Y CL -	N Y #F -	N Y HU -
c-	N Y HU -	N Y #F -	N Y #F -	N Y CL -	N Y #F -	N Y UG -

335	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N N GU -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
b-	N Y CL -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N N CA M	N N GU -	N Y UN -	N N GU -	N N GU -	N Y UG -
c-	N N GU -	N Y #F -	N N GU -	N Y #F -	N N UN -	N N GU -

336	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
b+	N Y #F -	N Y #F -	N N OP O	N Y #F -	N Y #F -	N Y #F -
b-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -
c+	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y UG -	N Y #F -
c-	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -	N Y #F -

APPENDIX C

NUMBER SET ASSIGNMENT FOR NUMBER TRIPLES

Number Set Assignment

Student ID#

Level	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116
b+	2	5	3	5	5	4	4	2	1	5	3	2	6	4	4	3
b-	1	1	6	2	1	6	3	1	4	4	5	4	5	2	3	2
c+	6	1	2	6	1	3	3	6	3	4	5	4	5	3	3	1
c-	3	6	4	2	6	2	6	3	5	1	4	3	2	4	6	4

Student ID#

Level	117	118	119	120	121	123	124	125	127	128	129	130	131	132	133	134
b+	1	1	5	6	6	4	3	6	3	4	4	5	6	1	5	1
b-	5	4	2	3	4	3	2	1	6	1	6	4	5	3	4	6
c+	5	3	6	4	2	3	1	1	2	5	3	4	5	6	4	2
c-	6	5	2	6	3	6	4	5	4	1	2	1	2	5	1	5

Student ID#

Level	135	137	139	140	141	143	144	147	148	151	152	153	154	155	158	159
b+	5	1	4	1	5	6	6	5	4	3	3	1	2	1	6	2
b-	2	6	2	4	3	3	4	3	2	5	6	5	5	6	2	4
c+	6	2	3	3	6	4	2	6	3	5	2	5	1	2	2	4
c-	2	5	4	5	1	6	3	1	4	4	4	6	3	5	1	3

Student ID#

Level	160	162	163	164	165	166	167	168	169	170	171	172	173	175	177	301
b+	3	3	5	2	3	2	6	6	2	6	6	5	3	1	6	4
b-	2	5	3	6	1	1	2	4	4	2	3	1	1	5	5	2
c+	1	5	6	1	4	6	2	2	4	2	4	1	4	5	5	3
c-	4	4	1	2	5	3	1	3	3	1	6	6	5	6	2	4

Student ID#

Level	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	318
b+	1	5	6	3	4	3	1	6	2	6	6	1	4	4	6	5
b-	4	2	4	2	6	6	3	3	5	5	3	6	2	3	2	4
c+	3	6	2	1	3	2	6	4	1	5	4	5	3	3	2	4
c-	5	2	3	4	2	4	5	6	3	2	6	6	4	6	1	1

Student ID#

Level	319	320	321	322	323	325	327	328	329	330	331	332	333	334	335	336
b+	5	5	4	3	3	2	5	3	3	2	4	5	1	2	6	1
b-	4	1	1	6	5	1	3	2	5	5	6	2	6	4	2	3
c+	4	1	5	2	5	6	6	1	5	1	3	6	2	4	2	6
c-	1	6	1	4	4	3	1	4	4	3	2	2	5	3	1	5

Center Planning and Policy Committee

Richard A. Rossmiller
Center Director

Dale D. Johnson
Area Chairperson
Studies in Language:
Reading and Communication

Marvin J. Fruth
Area Chairperson
Studies in Implementation
of Individualized Schooling

Penelope L. Peterson
Area Chairperson
Studies of Instructional Programming
for the Individual Student

James M. Lipham
Area Chairperson
Studies of Administration and
Organization for Instruction

Thomas A. Romberg
Area Chairperson
Studies in Mathematics and Evaluation
of Practices in Individualized Schooling

Associated Faculty

Vernon L. Allen
Professor
Psychology

B. Dean Bowles
Professor
Educational Administration

Thomas P. Carpenter
Associate Professor
Curriculum and Instruction

W. Patrick Dickson
Assistant Professor
Child and Family Studies

Lloyd E. Frohreich
Associate Professor
Educational Administration

Marvin J. Fruth
Professor
Educational Administration

Dale D. Johnson
Professor
Curriculum and Instruction

Herbert J. Klausmeier
V.A.C. Henmon Professor
Educational Psychology

Joel R. Levin
Professor
Educational Psychology

James M. Lipham
Professor
Educational Administration

Dominic W. Massaro
Professor
Psychology

Donald M. McIsaac
Professor
Educational Administration

Wayne Otto
Professor
Curriculum and Instruction

Penelope L. Peterson
Assistant Professor
Educational Psychology

Thomas S. Popkewitz
Professor
Curriculum and Instruction

Gary G. Price
Assistant Professor
Curriculum and Instruction

W. Charles Read
Professor
English and Linguistics

Thomas A. Romberg
Professor
Curriculum and Instruction

Richard A. Rossmiller
Professor
Educational Administration

Peter A. Schreiber
Associate Professor
English and Linguistics

B. Robert Tabachnick
Professor
Curriculum and Instruction

Gary G. Wehlage
Professor
Curriculum and Instruction

Louise Cherry Wilkinson
Associate Professor
Educational Psychology

Steven R. Yussen
Professor
Educational Psychology

10/79

BEST COPY AVAILABLE